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AND
PANORAMA SKETCHING

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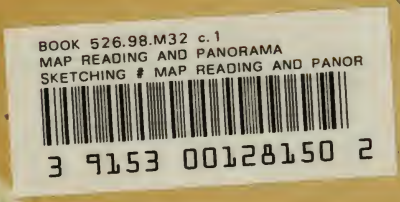

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MAP READING

AND

PANORAMA SKETCHING

BY

AN INSTRUCTOR

SECOND EDITION, REVISED AND ENLARGED

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INTRODUCTION

A KNOWLEDGE of Military Topography is essential to military studies and military operations. It is not necessary, however, for every officer to be able to make accurate maps of country hitherto indifferently mapped, or not mapped at all ; that is the work of specialists.

All officers must be able to read a map, and all officers should be proficient in field sketching ; this book, therefore, is primarily intended to explain all that is necessary for officers of the various services to know of the subject. Efficiency will be the result of constant practice.

It must not be imagined that it is necessary to be an accomplished draughtsman, or to be the possessor of elaborate instruments to make a map or a panorama sketch. It is not. Draughtsmen may be tempted to think too much of the drawing at the expense of the military value of the sketch, and elaborate instruments are quite unnecessary.

Clearness and accuracy are essential for military sketching, and can be acquired by all.

A description of the use of the prismatic compass has been included, as it is so closely allied with map work.

1. MAP READING AND SKETCHING.

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1. SCALES.

Explanation.

All maps and military sketches are drawn to scale.

A scale denotes the proportion which distances on the map bear to the actual distances on the ground. If one could imagine a drawing made in a stationary balloon on a sheet of glass let into the floor of the basket the principles of a scale would become evident. If the glass were 4 in. square and the area of country seen beneath and drawn on the glass 4 miles square, the drawing would be to a scale of 1 in. to 1 mile. If the balloon descended and 1 mile square of country be seen and drawn, the scale would then be 4 in. to 1 mile.

The necessity for scales is obvious. By their use it is possible to show any area of country—large or small—to any size required. A scale must be attached to every map or sketch, and the moment a map is opened the scale must be examined so that the length of actual ground represented by any distance on the map may be grasped.

Scales in the United Kingdom, India and Canada are in inches and miles. Scales on foreign maps and (in principle) on the maps of the British African colonies are metrical.

Scales for Military Maps.

When about to make a map or plan the first thing to decide upon is the scale to be adopted, and to draw it out at the bottom of the paper is the next step.

Scales are known as "Small Scales" and "Large Scales." Small scales are scales of miles to the inch, and are shown in miles and fractions of a mile. Strategical maps are drawn to small scales. Large scales are scales of inches to the mile, and are shown in tens,

hundreds, and thousands of yards. Such scales are used for tactical purposes where ranges must be ascertained and indicated.

The scale of a map must be regulated according to the area of country to be shown, the object of the sketch, and the amount of detail required.

The following are the scales usually adopted in military sketching :—

Large tracts of country	Scales of	½ in. and 1 in. to the mile.
Roads, Rivers, etc. .	,,	1 in. to 4 in. ,,
Outpost and other positions . .	,,	1 in. to 6 in. ,,
Towns and Villages to be placed in a state of defence . .	,,	4 in. to 10 in. ,,
Billeting Areas, Bivouacs, etc. . .	,,	4 in. to 12 in. ,,

On Army Book 153 the area of country that can be shown to different scales, leaving the minimum amount of room for the necessary heading, scale and signature, is as follows :—

Scale 1 in. to 1 mile . . .	6 × 4½ miles.
,, 4 in. ,, . . .	2500 × 2000 yards.
,, 6 in. ,, . . .	1600 × 1300 ,,
,, 10 in. ,, . . .	1000 × 800 ,,
,, 12 in. ,, . . .	850 × 650 ,,

If a sketch must be made very hurriedly and under difficult conditions, and, although its relative proportions are correct, it has no definite scale, it is customary to mark off distinctly and figure some known length of road, river, fence or any other feature. This will show the proportion the sketch bears to the ground (see Plate XIV.).

Expressing the Scale.

Scales are expressed in three ways, and all three must be shown.

1. The Statement of Scale.

A statement of the number of inches to the mile, miles to the

inch, centimetres to the kilometre, etc. British maps are usually known by the "statement," such as "½ in.," "1 in." or "6 in." maps.

2. The Representative Fraction.

This is usually written R.F. The R.F. means the proportion any unit on the map bears to the actual length on the ground represented by that unit, or, in other words, the number of times lengths on the map are smaller than the real lengths on the ground. It is understood in all languages and with all methods of measurement. It can be described as :

$$\frac{\text{Unit on Map}}{\text{Length of ground represented by that unit}}, \text{ or simply } \frac{\text{Map}}{\text{Ground.}}$$

The "Unit on Map" is always 1. Both "Map" and "Ground" must be shown in the same unit of measure whether inches, yards, centimetres or miles. If the unit of the map is 1 in., then the length represented by that unit 1 in. must also be shown in inches; if the unit of the map is a centimetre, then the length of actual ground represented by that centimetre must also be shown in centimetres.

If, on a road, the distance between two bridges is 1000 yds. and this is shown on the map as 3 in., then :—

$$\frac{\text{3 in. [Map]}}{1000 \times \text{[Ground (} \times 36 \text{ to bring to inches)]}} = \frac{3}{1000 \times 36} = \frac{1}{12,000}$$

= R.F. of the map.

If it were desired to make a map or plan of a room 60 ft. × 30 ft. on a piece of notepaper, say, 3½ in. × 7 in., a convenient scale to use would be one of 10 ft. to 1 in., then 60 ft. × 30 ft. would be shown on the paper as 6 in. × 3 in., and, as there are 120 in. in 10 ft., the R.F. of the plan would be $\frac{1}{120}$, or, as it may be written, 1 : 120.

Continental maps are generally known by the R.Fs., such as the "$\frac{1}{80,000}$" "$\frac{1}{100,000}$" or "$\frac{1}{250,000}$" maps. The R.F. on a foreign map is a great convenience, as from it can be shown with little trouble the corresponding English scale. An example will be shown of the method of constructing a scale graduated in English units for a map, the scale of which is metrical, making use of the R.F.

3. The Plain Scale.

This is the scale which is actually drawn out at the foot of a drawing (Plate I), and one from which measurements can be taken by dividers, paper and pencil, or, approximately, the fingers. It should be from 4 to 6 in. long for a military sketch—the full length of the page according to which way the book is used—so that the greatest length required can be readily measured off. The portion on the right of zero is split up into primary divisions—the large units of measure, and the portion on the left shows the secondary divisions or smaller units.

The unit of measure for the scale must always be stated at the end of the line.

Before attempting the construction of scales the following figures should be studied, as by committing a few of them to memory the drawing out of scales is greatly simplified.

Important Figures.

1 geographical mile = 1·152 statute miles. 60 geographical miles = 1 degree at the equator.

1 mile = 1760 yards = 5280 feet = 63,360 inches.

1 metre = 39·4 inches. 1 inch = 2·54 centimetres. 100 metres = 328 feet. 1 kilometre = 1093 yard, approximately $\frac{5}{8}$ mile.

1 verst = 1167 yards, or ·663 miles. (Russian measure.)

English Maps.

Scale of 2 miles to 1 in = R.F. $\frac{1}{126,720}$.

Scale of 1 in. to 1 mile = R.F. $\frac{1}{63,360}$.

Scale of 4 in. to 1 mile = R.F. $\frac{1}{15,840}$.

Scale of 6 in. to 1 mile = R.F. $\frac{1}{10,560}$.

Scale of 10 in to 1 mile = R.F. $\frac{1}{6336}$.

Continental Maps.

R.F. $\frac{1}{10,000}$ = 10 cm. to 1 km. = 6·34 in. to 1 mile.

R.F. $\frac{1}{20,000}$ = 5 cm. to 1 km. = 3·17 in. to 1 mile.

R.F. $\frac{1}{25,000}$ = 4 cm. to 1 km. = 2·53 in. to 1 mile.

R.F. $\frac{1}{40,000}$ = 2·5 cm. to 1 km. = 1·58 in. to 1 mile.

R.F. $\frac{1}{50,000}$ = 2 cm. to 1 km. = 1·26 in. to 1 mile.

R.F. $\frac{1}{80,000}$ = 1·25 cm. to 1 km. = 1·26 mile to 1 in.

R.F. $\frac{1}{100,000}$ = 1 cm. to 1 km. = 1·58 mile to 1 in.

R.F. $\frac{1}{126,000}$ = "3 verst" map = 1·988 mile to 1 in.

R.F. $\frac{1}{200,000}$ = 2 km. to 1 cm. = 3·16 miles to 1 in.

R.F. $\frac{1}{250,000}$ = 2·5 km. to 1 cm. = 3·94 miles to 1 in.

International Map.

R.F. $\frac{1}{1,000,000}$ = 10 km. to 1 cm. = 15·76 miles to 1 in.

Construction of Scales.

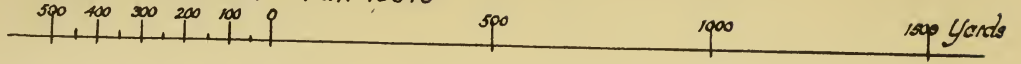
The following examples should explain all that it is necessary to know in working out scales for military maps and sketches. Scales should be neatly, accurately and firmly drawn with a finely pointed pencil, but as they must often be made under most unfavourable conditions in the field, it is wise to practise making them without

PLATE I

EXAMPLES OF SCALES

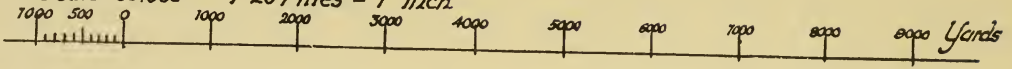
1

Scale 4" = 1 Mile. R.F. 1/15840



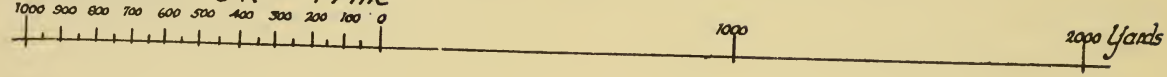
2

Scale 1/80.000 1·26 Miles = 1 Inch.



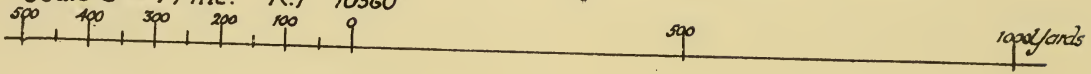
3

Scale 1/20.000 3·17" = 1 Mile



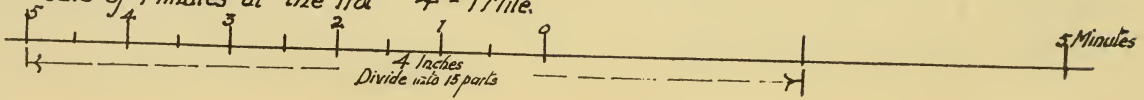
4

Scale 6" = 1 Mile. R.F. 1/10560



5

Scale of Minutes at the Trot 4" = 1 Mile.



any instruments; instruments such as dividers are, in fact, quite unnecessary. A piece of paper, marked to the desired length, and then carefully folded in the centre, will always divide a line equally, and by doing this as often as may be required, and also sub-dividing by trial, any scale can be made with sufficient accuracy.

1. To construct a scale of 4 in. to 1 mile (Plate I, 1). As this is a scale of inches to the mile, and, therefore, a "large scale," it must be constructed to show yards. We know that 4 in. will equal 1760 yds., but, although 4 in. would be a suitable length for a scale, it would be a difficult matter to sub-divide the line into 1760 parts or components of that number, such as would be suitable for a scale. A round number is always desirable for simplicity in sub-dividing. If we tried 2000 it would mean a line longer than 4 in., but obviously not longer than 6 in., and therefore satisfactory. 2000 would also be a number that could be easily divided into hundreds or multiples of a hundred yards.

$$\text{If } 1760^{\times} = 4 \text{ in.}$$

$$1^{\times} = \frac{4}{1760}.$$

$$2000^{\times} = \frac{4 \times 2000}{1760} = \frac{50}{11} = 4{\cdot}54 \text{ in.}$$

Draw a line and mark off a distance of 4·54 in. On a piece of paper tick off the length of this line, and fold carefully so that the two ticks exactly coincide. The fold will give 1000 yds. Refolding half the paper will give us 500 yds. Mark the left-hand tick 500, the next 0, then 500, and then 1000 and 1500 at the end. From 0 to 1500 is the primary portion of the scale. The left-hand portion to show secondary divisions is divided into hundreds of yards. This is done by trial, and the fifties can be shown in the same way. The secondary divisions can now be figured.

To complete the scale the unit of measure, yards, must be stated at one end, and just above the scale must be printed the "Statement" and R.F.

By this method any English scale can—when necessary—be constructed.

2. To find the Statement of Scale from the R.F. of a map.

Small scales are scales of miles to the inch, and large scales are scales of inches to the mile. The R.F. $\frac{1}{63,360}$ denotes a scale of 1 mile to 1 inch, or, as it may be put, 1 inch to 1 mile. A fraction smaller than $\frac{1}{63,360}$ therefore will denote a small scale and a larger fraction a large scale.

(*a*) R.F. $\frac{1}{100,000}$; find the Statement of Scale (in English measure).

This is a small scale, therefore divide 100,000 by 63,360—the number of inches in a mile—and the answer will be miles to the inch. $100,000 \div 63,360 = 1 \cdot 58$ miles to 1 in.

(*b*) R.F. $\frac{1}{25,000}$; find the Statement of Scale (in English measure.

This is a large scale, therefore divide 63,360 by 25,000, and the answer will be inches to the mile. $63,360 \div 25,000 = 2 \cdot 53$ in. to the mile.

3. To construct a scale of $\frac{1}{80,000}$ to show yards. The R.F. is 1 : 80,000, therefore 1 yd. on the map = 80,000 yds. on the ground. One-sixth of a yard—6 in.—is of course a suitable length for a scale, but one-sixth of 80,000 gives a very awkward number. One-eighth of a yard—4½ in.—is a convenient length, and an eighth of 80,000 is 10,000, a good round number. Draw a line 4½ in. long, and by the method of folding paper and trial subdivisions divide into 10 parts, and the scale can be drawn as shown (Plate I, 2). The primary divisions show thousands of yards and the secondary hundreds.

4. To construct a scale of $\frac{1}{20,000}$ to show yards. Since 1 yd. or 36 in. equals 20,000 yds., 6 in. will equal 3333·3 yds. Again a

round number is essential, and 3000 would probably give a suitable length of scale.

$$20{,}000^{\times} = 36 \text{ in.}$$

$$1^{\times} = \frac{36}{20{,}000}$$

$$3000^{\times} = \frac{36 \times 3000}{20{,}000} = 5{\cdot}4 \text{ in.}$$

A line 5·4 in. long is drawn. This line cannot readily be divided into three parts (to show thousands of yards) by folding paper, so it must be done by trial, and the scale is finished as in the previous examples (Plate I, 3).

In such examples as (4) it is necessary to draw a line to one or two places of decimals in length. Such a line must be taken from the diagonal scale on the service protractor. If a protractor is not available it is better to work out these scales by considering the R.F. as being in feet.

5. To construct a scale of $\frac{1}{40{,}000}$ to show yards.

1 ft. on the map = 40,000 ft. on the ground,
therefore 6 in. ,, = 20,000 ft. ,,

Draw a line 6 in. long, divide it into 20 equal parts each equalling 1000 ft., and mark off every 3090 ft. and figure as 1000 yds. Complete the scale by showing division of 100 yds. on the left or secondary portion of the scale.

6. To construct a scale of yards from the R.F. of any Continental Map.

R.F. (say) 1 : 50,000. $1^{\times} = 50{,}000^{\times}$

$36 \text{ in.} = 50{,}000^{\times}$

Divide both sides by 10, then $3{\cdot}6 \text{ in.} = 5{,}000^{\times}$

A line 3·6 in. long is drawn and divided into 5 parts. To make the scale the required length, 1, 2, 3 or more lengths representing $1000^{\times}$ are added.

7. To make a scale of 6 in. to 1 mile from the service protractor. On the service protractor will be found a scale of 2 in. to 1 mile to show hundreds of yards. 300 yds. to this scale will equal 100 yds. to a scale of 6 in. to 1 mile. Place the protractor on the paper and mark off every 300 yds. up to 1500 to show the secondary division 500 to 0. 3000 and 4500 will show the primary divisions of 500 and 1000, and the scale can be completed (Plate I, 4). N.B.—The primary divisions of the scale might equally well show hundreds of yards, and the secondary tens. The R.F. is easily arrived at. To a scale of 1 in. to 1 mile, 1 in. on the map equals 63,360 in. on the ground. For the scale of 6 in. to 1 mile, 6 in. on the map equals 63,360 in. on the ground; therefore 1 in. will equal 10,560 in. R.F. $\frac{1}{10,560}$.

Time and Comparative scales are occasionally useful. Comparative scales are those having the same R.F. but with different graduations. A scale to show both paces and yards would be an example (Plate XV.).

8. To construct a scale to show paces—Scale of Sketch already shown. Assume the length of a pace to be 30 in. A pace, then, equals $\frac{5}{6}$ of a yard, and 600 paces will equal 500 yds. Below the scale of yards of the sketch mark off lengths of 500 yds., and divide each length into 6 parts each representing 100 paces. For the secondary portion of the scale mark off a length of 100 paces and divide up to show every 10 paces. At the end of the scale the unit of measure—paces—must be printed.

A scale of paces can be similarly made for any length of pace.

9. Time scales are of use when covering large areas of ground on horseback. The rate at which a horse walks, trots or canters is known, and a scale can be constructed to show how much ground has been covered in a given time. Suppose a map is to be made, on horseback, to show a certain tract of country to a scale of 4 in. to 1 mile. A horse trots at 8 miles an hour. 1 mile therefore will be covered in $7\frac{1}{2}$ minutes. To the required scale 1 mile equals 4 in. Draw a line 4 in. long and divide into 15 parts each of which will

show a half minute. Working from left to right, mark off every second division, and these will represent minutes. Five minutes thus subdivided will show the secondary divisions, and further length equal to 5 minutes are marked off to complete the scale (Plate I, 5).

Time and Distance scales are also of use for infantry on the march. To make a time scale for a body of troops marching at the rate of $2\frac{3}{4}$ miles an hour, including halts, for a map to a scale of 2 miles to the inch. On the scale for the map tick off a length of $2\frac{3}{4}$ miles. This will represent the distance covered in 1 hour. Divide into 6 parts, each representing 10 minutes, and subdivide again to show every 5 minutes, and the "secondary" portion of the scale is complete. Tick off to the right further lengths of $2\frac{3}{4}$ miles, and representing 1 hour, for the "primary" portion, and the scale is made. By this method a time scale can be added to the scale of any map for the movement of any troops.

On the service protractor will be found scales of $\frac{1}{2}$ in., 1 in., 2 in. and $2\frac{1}{2}$ in. to the mile showing hundreds of yards. On it will also be found scales showing both yards and miles for the R.Fs. 1 : 80,000, 1 : 100,000 and 1 : 250,000. From these scales most of the scales likely to be used can be made. From the 2 in. scale 3 in., 4 in., 6 in. (as already explained), 8 in., and 12 in. scales can be constructed, and from the $2\frac{1}{2}$ in. scales of 5 in. and 10 in. to the mile. From the scale for 1 : 80,000 one can make scales the R.Fs. of which are 1 : 40,000, 1 : 20,000 and 1 : 10,000, and from the 1 : 100,000 scales for 1 : 50,000 and 1 : 25,000.

A large scale such as 10 yds. to the inch can be made from the service protractor, using the diagonal scale. Each inch on the right-hand portion of the protractor will show the primary division of 10 yds., and the tenths on the left will give the smaller unit—1 yd. —for the secondary portion of the scale. Any scale of yards to the inch can be readily drawn in a similar manner.

Army Book 153 is ruled with $\frac{1}{4}$ in. squares; with it, therefore, it is easy to show fractions of a mile for various scales, and to show yards for scales of yards to the inch. For such scales as 20, 40 or 100 yds. to the inch each $\frac{1}{4}$ in. square would represent lengths of

5, 10 or 25 yds., and so on, and the secondary portion of a scale is easily constructed. Eleven squares to a scale of 4 in. to 1 mile approximately = 1200 yds., and to a scale of 6 in. to 1 mile = 800 yds., good round numbers to deal with, and ones easily divided into hundreds of yards.

Distances in field sketching are usually transferred from the scale to the map by ticking off on a piece of paper, which can be folded and refolded to give a clean edge. It may sometimes be convenient to have the scale on a separate piece of paper while working, If this be done, when the sketch is complete the scale must, of course, be copied at the bottom of the map.

2. CONVENTIONAL SIGNS.

The conventional signs used in field sketching differ slightly from those used on published maps, the former being naturally simpler to draw.

In the accompanying plates the signs shown are those which are in general use in the preparation of field sketches. The conventional signs used on Ordnance maps (which vary according to the scale), Continental maps, and maps specially prepared for trench warfare, are generally shown, with explanations, at the foot of the respective maps.

The clearness of a sketch map—which is all important—will depend largely upon the way the various conventional signs are shown ; practice, therefore, in drawing them out neatly and accurately is most essential.

Care must be taken to keep the conventional signs "in scale." One of the greatest difficulties is the tendency to make the various symbols too large, quite irrespective of the scale to which the map is drawn. All the symbols must be relatively correct in size and proportionate to the scale of the map, and the paper should be so held that when drawn they read the right way up.

Many of the conventional signs are shown in colour. In the field chalks are generally used, the colour being shown by lines drawn across the space to be coloured in the case of woods, and by one or two rings in the case of ponds and lakes, rather than filling in the area solid. The greasy nature of the chalks makes it impossible to write over paper coloured solidly.

It will usually be necessary to supplement the conventional signs by notes.

If at any time it is thought necessary to supply some new

symbol—which is quite permissible—the meaning must be explained by marginal reference.

Roads (Plate II. (1)) are shown by firm continuous lines when enclosed by any obstacle, wall, ditch, fence or iron railing. A note should state the nature of the obstacle. When unenclosed the road is shown by dotted lines. If there is any considerable space between the fence and the metalled portion of the road, the road will be shown with dotted lines, and lines for the fences will also be drawn in the proper positions. Roads which have 14 ft. of good metalled surface are called first-class roads and are coloured light brown. The width of metalled surface should be figured. Roads indifferently metalled and likely to be cut up in bad weather are dotted brown, and unmetalled roads are uncoloured. Unfenced cart tracks are shown by dotted lines, and a single dotted line denotes a footpath.

Rivers (2) are shown by blue lines. If of greater width than 12 ft. double lines are used. An arrow indicates the direction of the flow. Streams which have run dry are shown by black lines. Lakes and ponds are shown at (3). The colour, if chalk, should be put on in rings. Bridges are shown at (4). The materials of which they are constructed should be noted. (5) is the conventional sign for a bridge with piers. A ford or ferry is shown by note.

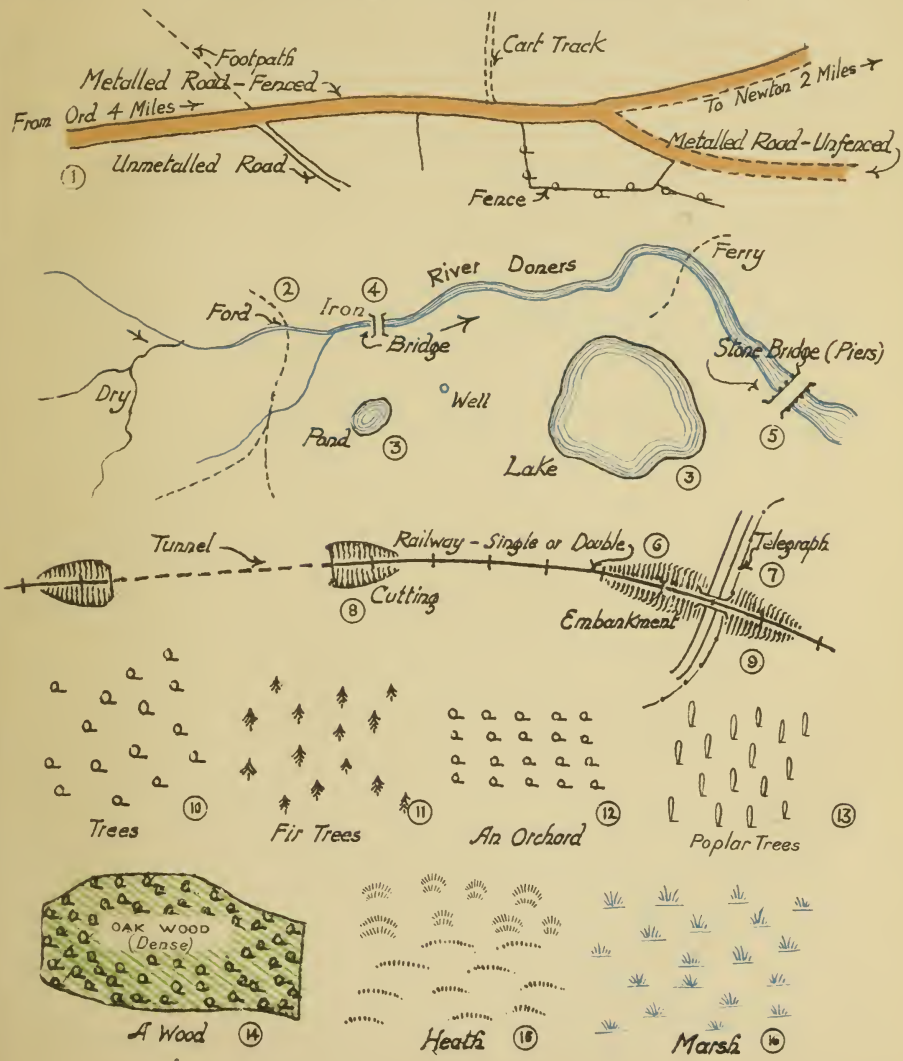
Railways (6).—Railways are shown by thick black lines with occasional short cross lines. Note must be made whether single or double. When passing through a tunnel the lines are dotted. (7) shows telegraph wires. A cutting is shown at (8), and an embankment at (9). Note thicker ends of short lines are next the higher ground.

Trees.—All trees except coniferous trees are shown as at (10), though poplar trees may be shown as at (13). Coniferous trees are shown at (11). On a map to a scale of 4 in. = 1 mile approximately one tree would be drawn to represent every six or eight on the ground (Plate VII.). For orchards the trees are regularly spaced (12).

Woods.—A wood is shown at (14). The name or any characteristic feature of the wood is printed on, and green lines are drawn diagonally across to fill the remainder of the space. Trees are drawn in addition if time permits.

PLATE II

CONVENTIONAL SIGNS. 1



Heath.—The conventional sign for a heath is shown at (15). The double rows of ticks are used to denote furze and whins.

Marsh.—The conventional sign—in blue—for a marsh is shown at (16).

Villages.—On small scale maps, such as those of 1 in. to 1 mile, villages are shown as at Plate III. (17). On large scale maps the individual buildings are shown (18).

Quarries.—A quarry is shown on fig. (17), and a sand (or gravel pit) on fig. (19).

Buildings (20) shows the symbols for churches. Inns, post offices, etc., have no special symbols, but are shown by note. P. denotes a post office and T. telegraph. Windmills, windpumps and wells are shown as at (21).

Obstacles.—The conventional sign for obstacles is shown at (22).

Demolitions.—Areas that have been demolished are shown by diagonal red lines (23).

Fortifications.—Fortified towns and cities are shown by the symbol (24). A single fort is shown by one irregular pentagon.

Troops (25) shows the signs used for different formations of the various arms. Arms having no special symbol can be shown as for infantry with letters, e.g. R.E. Enemy forces are shown in blue. Ticks show in which direction the troops face or are moving.

Trenches.—Fire trenches are shown with a thick red line (26). If traversed the fire-bays may be indicated. Communicating and other trenches are shown with a thin red line. Breastwork is shown by a thick and thin red line (27).

Enemy's Tracks.—These are denoted by three dotted red lines (28).

Entanglements.—Barbed wire entanglements are shown as at (29), the single line on small scale maps and the crossed lines on large scale maps and sketches. Chevaux-de-frise as at (30).

Gun Emplacements.—An emplacement for a field gun is shown at (31), for a machine gun at (32). A trench mortar is shown by a double ring and dot.

Ground Cut up by Artillery Fire is shown by a stippling of red dots (33).

Other symbols are given on Plate XVI., together with sections and small hand sketches, which are valuable additions to maps and may be shown, with the necessary notes at the foot of the sketch.

Notes.

Many features of military importance can be shown by note only.

Conventional signs should, when necessary, be supplemented by notes, which must be clear, legible and always relevant to the objects for which the map is being made.

One of the chief considerations in making a map is that it shall be easily read. Overcrowding the face of the sketch with notes must therefore be avoided, and notes, if numerous, may be placed in the margin with a line and arrow head pointing to the feature referred to. The best method, however, is to tabulate as many notes as possible at the foot of the sketch and use a reference number or letter (Plate XVII.)

Information can be given by note only upon such points as the following :—

The Ground Generally.—Whether broken up and affording good cover. Obstacles to free movement of troops, guns, etc. Dead ground. Field of fire. Nature of crops in fields. Commanding positions.

Roads.—Width. Condition of metalling. Nature and height of fences. Gradients. Ease of deployment.

Rivers.—Width and depth. Condition of banks. Liability to flood, etc.

Marshes.—Nature and extent.

Railways.—Single or double. Suitability for marching troops.

Bridges.—Width. Materials. Weight of traffic carried, etc.

Culverts.—Width. Thickness of crown. Span.

Woods.—Whether dense or open. Nature of undergrowth. Whether passable to any or all arms. Cover.

Fences.—Of what material constructed. Height. Value as an obstacle or as giving cover.

Buildings.—Suitability for defence. Cellars. Observation posts.

PLATE III

CONVENTIONAL SIGNS. 2.

3. CONTOURS AND CONTOURING.

Methods of Showing Hill Features.

The real nature of any tract of country, however carefully and accurately it may be mapped, is not shown unless the hills and valleys and the varying levels and undulations of the ground are represented.

Maps for strategical or tactical purposes are valueless unless showing the conformation of the ground, and with the exception of sketches made to show billeting areas or buildings, no field sketch can be said to be complete unless the varying levels of the land are shown.

Hill features are shown by two distinct methods:—Hachures and Contours. Both methods are frequently combined, or other features introduced, in order that the hills and low-lying ground may be readily distinguished.

Hachures.—The method of hachuring might be described as the extensive and systematic use of the conventional sign for embankments. The hachures are short disconnected lines drawn in such a way as would more or less indicate the direction taken by water in flowing from the higher to the lower parts of the ground. The flatter the ground, the longer and further apart the hachures are; the steeper the slope, the shorter and closer. Summits having an almost perpendicular rise are shown by the conventional signs for rocks and escarpments, and the tops of hills which are flattish are left, like the low-lying ground, white.

The use of hachures is more general on Continental maps, and is best suited to maps of very small scale. It has the advantage of

showing at a glance the positions of hills and valleys, but it has the disadvantage of somewhat obscuring, especially in very hilly country, the detail of the map. It does not show any heights with exactness, and numerous spot levels on the map must be studied in addition.

Contours.—Contour lines are representations on paper of imaginary lines running along the surface of the ground at stated intervals (varying from 100 metres to 10 ft.) and at a uniform height above sea-level (Plate IV.). They show both the height and general conformation of the ground with exactness and without obscuring the detail. From a contoured map, however, the nature of the ground is not readily grasped, and when the vertical distance between any two successive contour lines is great, information as to changes in the nature of the slope between them cannot be shown.

The use of contours is general on British maps and military sketches.

Hill features are also shown on the published maps of the various countries by contours and hachures combined, by contours and shading, and by contours and altitude tints.

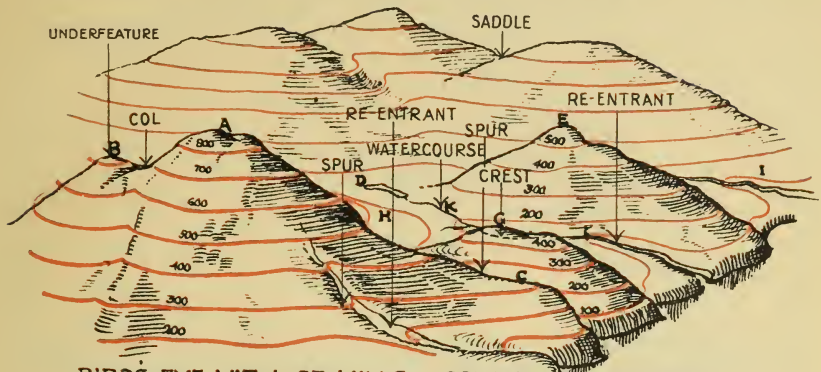
Contours and Hachures.—When the distance between two successive contours is large, hachures define the various underfeatures omitted by the contour lines, and if they are lightly drawn they do not obscure to any extent the detail of the map.

Contours and Shading.—The hills are shaded, the shade varying in strength according to the steepness of the slope. This enables the disposition of the hill features to be easily grasped.

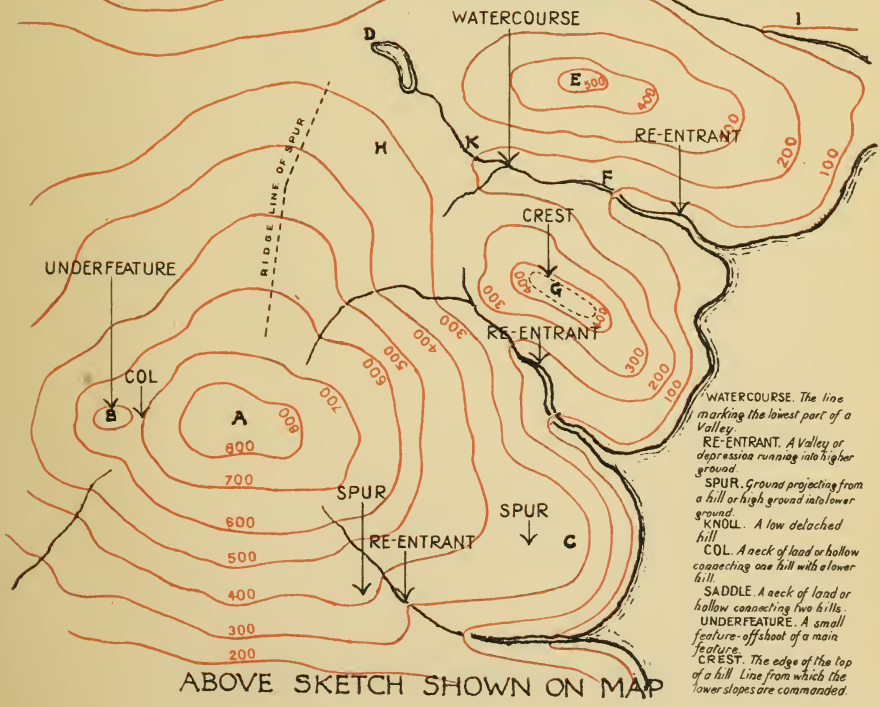
Contours and Altitude Tints.—Washes, or "layers," of colour are used to accentuate the rises in the ground. Green is generally used for the low-lying ground, a lighter shade of green for ground a 100 ft. or more above the sea-level, and brown for the hills, increasing in strength according to the height. By this method the relative heights of hills are clearly shown, but it is unnecessary if the vertical distance between contours is small, and when the ground rises to considerable altitudes the colour becomes so dark as to make it difficult to read the other features shown on the map.

EXAMPLES OF CONTOURS.

PLATE IV.



BIRDS EYE VIEW OF HILLS - CONTOURS MARKED



ABOVE SKETCH SHOWN ON MAP

WATERCOURSE. *The line marking the lowest part of a valley.*

RE-ENTRANT. *A valley or depression running into higher ground.*

SPUR. *Ground projecting from a hill or high ground into lower ground.*

KNOLL. *A low detached hill.*

COL. *A neck of land or hollow connecting one hill with a lower hill.*

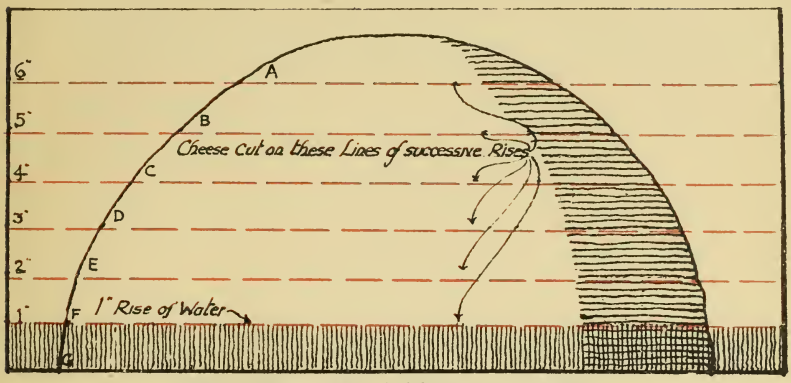
SADDLE. *A neck of land or hollow connecting two hills.*

UNDERFEATURE. *A small feature - offshoot of a main feature.*

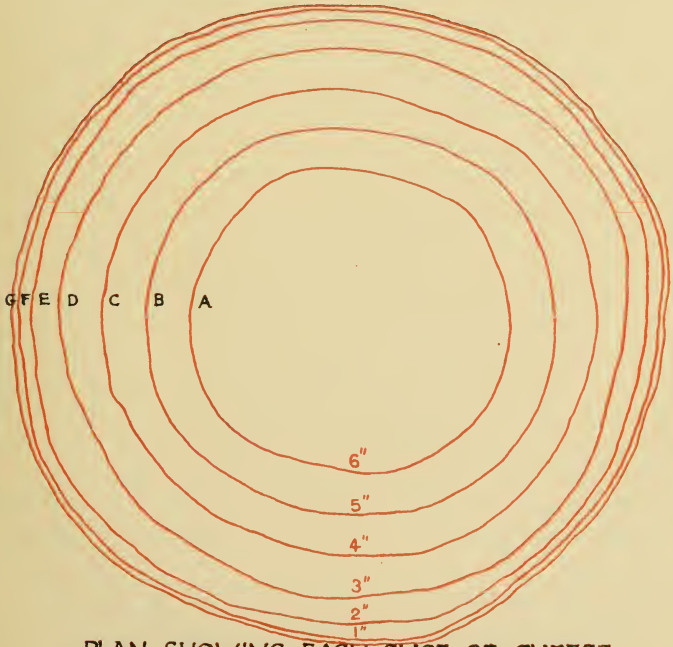
CREST. *The edge of the top of a hill. Line from which the lower slopes are commanded.*

EXAMPLES OF CONTOURS

PLATE V



SIDE VIEW OF CHEESE IN BASIN



PLAN SHOWING EACH SLICE OF CHEESE

Contours.

To show the length and breadth of an area of country on paper is a simple matter. To show the third dimension, i.e. height, it is necessary to clearly understand how features raised above the general level of the ground can be projected on to the "ground plane" and shown "in plan."

Imagine an immense sheet of paper at the level of the sea to cut right underneath a hill. Imagine another sheet of paper parallel to the first to cut through the hill, but 50 ft. higher. The intersection of the second sheet with the sides of the hill indicate a contour line, and if a huge pencil could be held perpendicularly and made to follow round the intersection, it would trace on the lower sheet the plan or actual shape of the hill at the intersection, and the line would represent the 50′ 0″ contour.

To thoroughly grasp what is meant by a contour line, the following experiment should be made (Plate V.) :—

Cut a Dutch cheese (or a large potato) in half and place one half in a basin. Assuming the half of the cheese to be 7 in. in height, pour water into the basin until there is sufficient to show a rise of 1 in. Then with a sharp penknife make a slit all round the cheese on the water-mark. Pour in more water until there are 2 in. in the basin, and make another slit on the new water-mark. Repeat the process until the water is 6 in. in height.

Next remove the cheese and cut into seven slices on the lines marked when in the basin. Place the bottom slice on a piece of paper and run a line round it with a red pencil. Place each slice in succession within this ring, marking off with the pencil in the same way. When the last ring has been drawn on the result will be a plan showing the "Contours" of the cheese at every inch in height.

Imagine the cheese to be an island, and imagine the sea to have risen 100 ft. Imagine, also, that a deposit of red seaweed is left. Imagine rises of 200 ft., 300 ft. and so on, each rise leaving its red deposit.

A view of the island from an aeroplane immediately above will show its plan with the contour lines at every 100 ft. interval.

The foregoing will explain the principle of contours, but it assumed features of simple hemispherical formation. It now remains to consider how the different formations of ground can be shown.

Reading Contours.

Plate VI. Imagine a knife to have cut perpendicularly, from top to bottom, through certain sloping ground, and the black lines on the upper part of the plate to show the resulting profiles. The red dotted lines show vertical heights of 100 ft., and from the points where these cut the profiles of the ground the contour lines could be traced along at a uniform height above the sea. The appearance of these contour lines as seen from above, in other words "in plan" or on the map, is shown by the firm red lines. The following slopes are represented :—

1. *Uniform Slopes* (1).—When the contours are evenly spaced, as seen on the plan, the shape represented is uniform, and there would always be the same horizontal distance to travel for each successive rise of 100 ft. Uniform slopes may be steep or may have an easy rise.

2. *Steep Slopes* (1).—If the contours are close together, there is a short distance to travel for every rise shown by the contours, and the ground is steep.

3. *Easy Slopes* (1).—If the contours are far apart, there is a considerable distance to be travelled between each rise shown by the contours, and the ground is not steep.

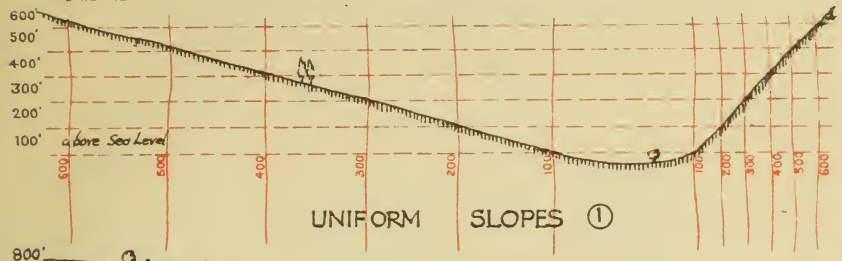
4. *Convex Slopes* (2).—If the contours—working from the lower to the higher ground—are closely spaced, becoming more widely spaced as greater height is reached, the rise is at first steep, becoming gradually flatter, and the ground is convex.

5. *Concave Slopes* (3).—If the contours—again working from the lower to the higher—are widely spaced, becoming more closely spaced as higher ground is reached, the rise at first is gradual, becoming steeper as one ascends, and the ground is concave.

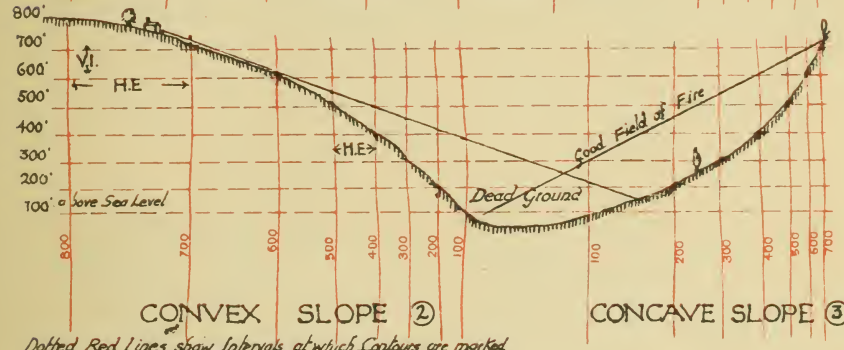
The preceding examples showed only the nature of slopes. Con-

EXAMPLES OF CONTOURS

PLATE VI

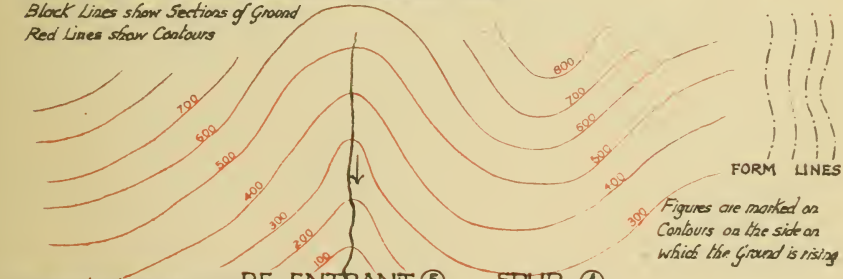


UNIFORM SLOPES ①



CONVEX SLOPE ② CONCAVE SLOPE ③

Dotted Red Lines show Intervals at which Contours are marked
Black Lines show Sections of Ground
Red Lines show Contours

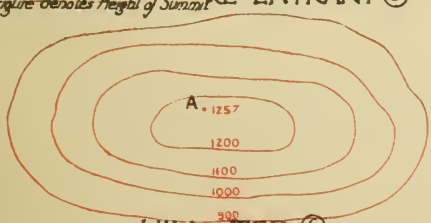


FORM LINES

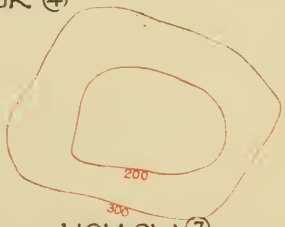
Figures are marked on Contours on the side on which the Ground is rising

A. *Figure denotes Height of Summit*

RE-ENTRANT ⑤ SPUR ④

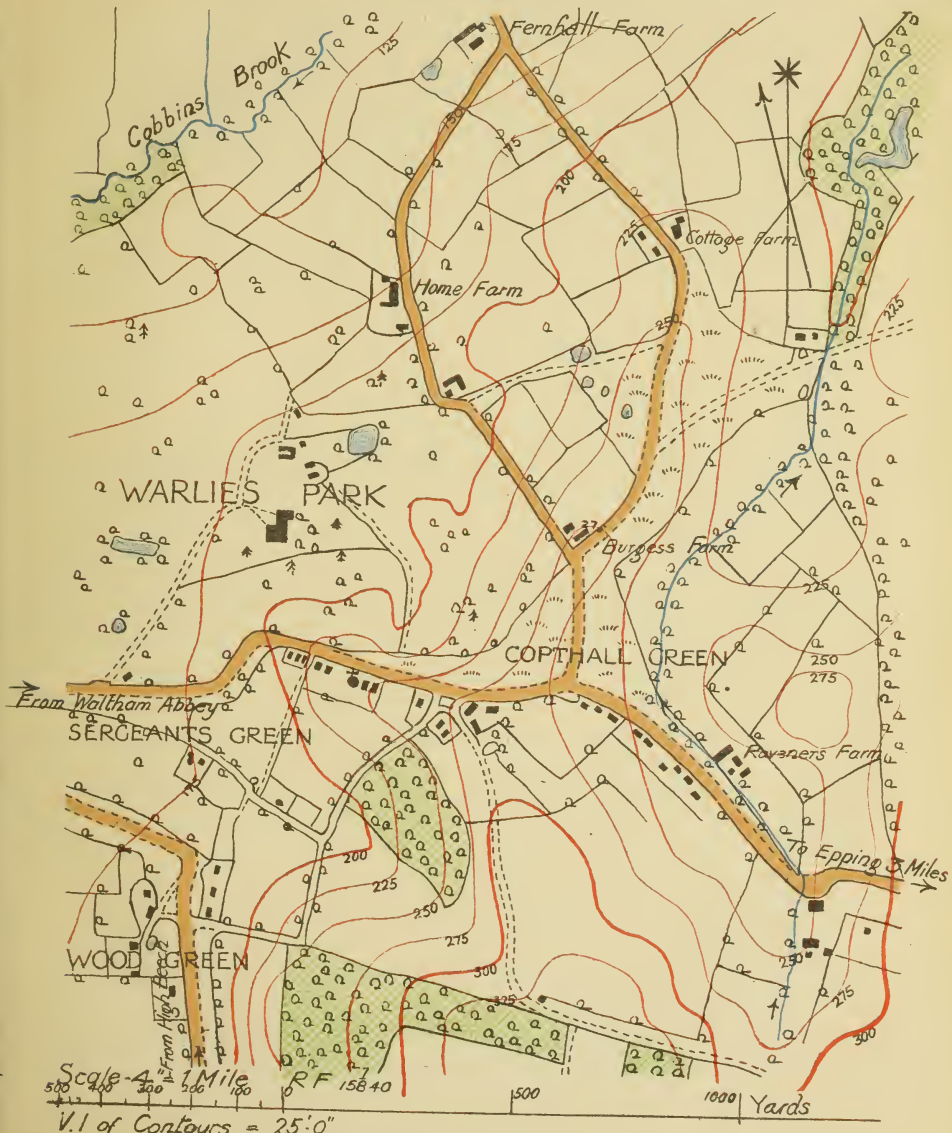


HILL TOP ⑥



HOLLOW ⑦

WALTHAM HOLY CROSS. ESSEX. PLATE VII



tours which show hills, depressions and folds in the ground must now be considered.

6. *Spurs* (4).—Contours which "bend" must be either salients—projections from higher ground usually known as spurs—or re-entrants—valleys or similar depressions. Note in which direction the ground rises, and a spur will be shown by lines which bend forward or protrude from the higher ground. If the contour lines are shown at a small vertical interval and are numerous, the higher numbers will be found on the inner lines.

7. *Re-entrants* (5).—A re-entrant will be shown by lines which bend in, or "make an indent" in the higher ground. If the contour lines are numerous, the higher numbers will be found on the outer lines. Rivers and streams will often mark the re-entrants.

8. *Hill Tops* (6).—Ring contours show hill tops. Depressions, which, however, are infrequently met with, are also shown by ring contours; to detect the hill top it must be noted that the figure is generally shown on the side of the contour on which the ground is rising.

9. *Hollows* (7).—Ring contours show depressions. If the figure is shown outside the ring the ground rises outside and the hollow is inside.

The contoured maps on Plates VII., VIII., IX. and X. show the formations of ground just described.

Walking along the road shown in the S.W. corner of Plate VII., the ground to the W. is practically flat, while to the E. it rises rapidly towards the wood. Turning eastwards to the N.W. corner of the wood, the lane rises at first but slightly, becoming steeper before the 250′ contour is reached at the corner of the wood. Turning northwards and continuing along the lane a re-entrant is crossed, and the lane will dip in and rise again. From the point where the 200′ contour crosses the lane by the second wood, walking along the 200′ contour the road from Waltham Abbey is reached. This road eastward runs practically up the centre of a spur, and the slope is convex—from the junction of the 200′ contour with the road ground E. of the church will be "dead."

Proceeding along the road to Copthall Green, the ground in

Warlies Park at first falls rapidly away towards the N. Turning N. at Copthall Green the road is fairly level, and runs partly along a pronounced spur shown by the 300′ and 275′ contours.

Turning to the left at Burgess Farm the road runs downhill to the 175′ contour, and the slope is a concave one. From the Home Farm to Fernhall Farm the road will first drop and then rise and drop again as the spur shown by the 150′ contour is crossed. Walking across country from Fernhall Farm E. by S. to the lake in the wood a spur is crossed, and the re-entrant in which the stream runs is reached. Following the stream to Ravener's Farm the ground rises very slightly.

A machine gun in position at the R in Ravener's Farm could not cover the long wood to the N. The spur marked by the 250′ contour intervenes, but an excellent field of fire could be obtained looking into the re-entrant due S. The ring contour figured 275′ shows a "hill top."

In a similar way the various formations of ground shown on Plates VIII., IX. and X. should be examined.

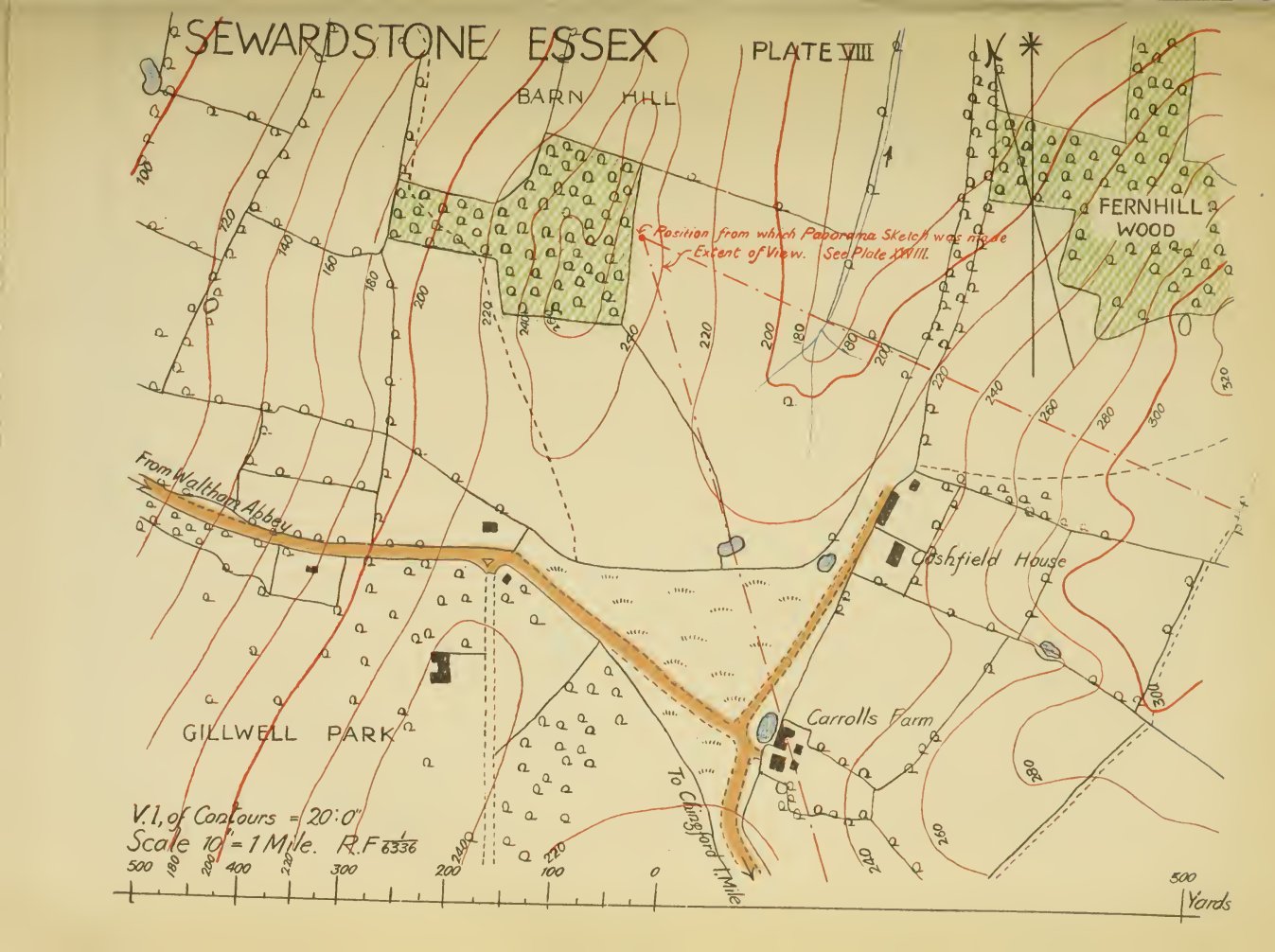
Official maps should be frequently studied, and an attempt made to picture the conformation of the ground. The country itself should then be seen, and the reason for any errors carefully considered.

With maps such as the British Ordnance maps, which have contours drawn at a large vertical interval, the hachures by which the contour lines are supplemented give much additional information. The actual shape of the ground between the contours, if not normal, is clearly shown, and many important little underfeatures can only be indicated—when the interval between contours is large—by this method.

Figured heights to certain parts of the ground are also useful additions to most maps. As with hachures, they help to show the nature of the slopes between contours, and frequently mark the summits of hills and commanding positions.

The following are shown on maps :—

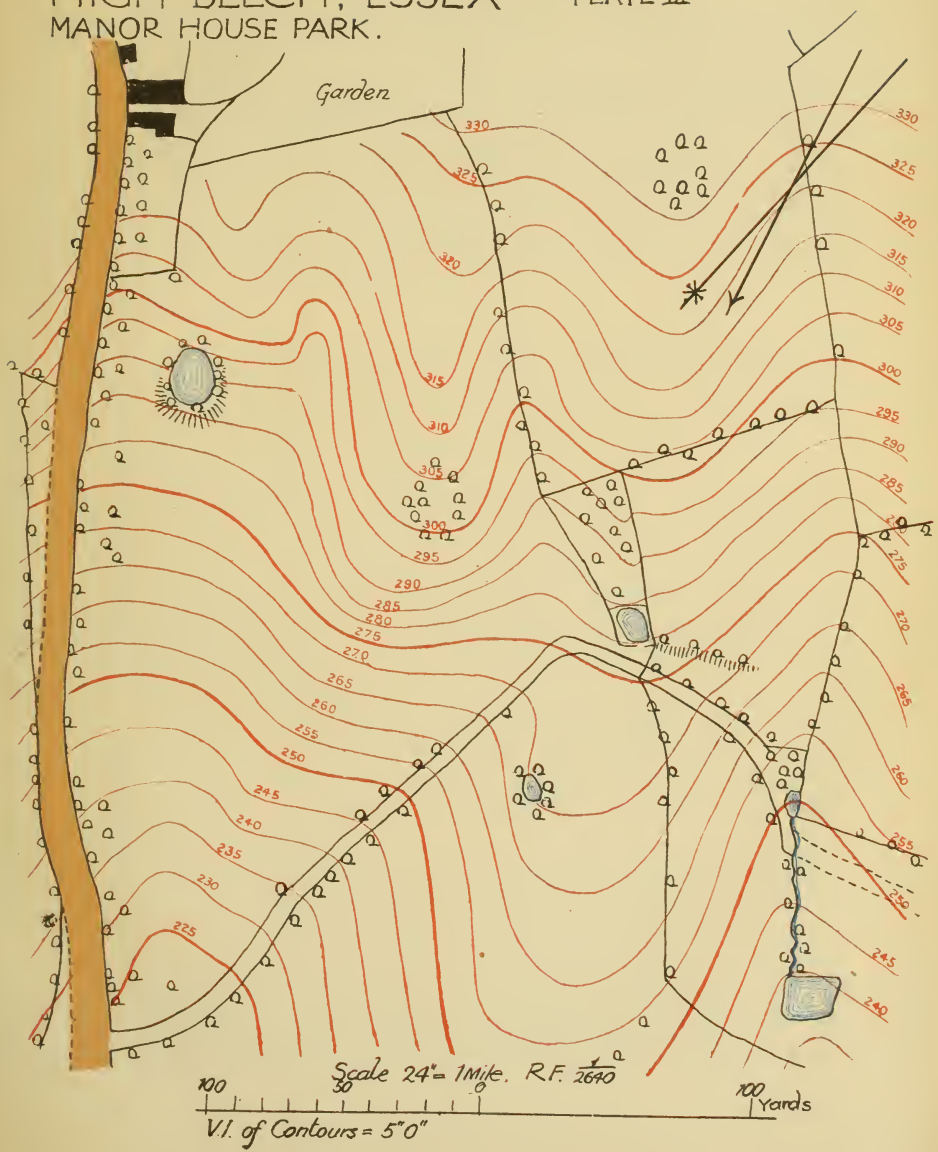
Trigonometrical Station : △659. These are usually shown on


SEWARDSTONE ESSEX
PLATE VIII
BARN HILL
FERNHILL WOOD
Position from which Paporama Sketch was made
Extent of View. See Plate XVIII.
From Waltham Abbey
Cashfield House
Carrolls Farm
GILLWELL PARK
To Chingford 1 Mile
V.I. of Contours = 20'-0"
Scale 10" = 1 Mile. R.F 1/6336
500 180 200 400 240 300 200 240 100 0
500 Yards

HIGH BEECH, ESSEX

PLATE IX

MANOR HOUSE PARK.



the tops of hills and commanding ground on British and Colonial maps.

Bench Mark: B.M.436↑. Shown on large scale Ordnance Maps. The arrow, denoting the point at which the height is given, is found on the plinth of buildings, culverts, posts, etc.

Spot Levels: ·142. These are marked on British maps on roads. There is nothing to identify them on the ground. They assist in estimating gradients. On Continental maps they are shown on the summits of hills and many other spots.

Contouring.

Accurate contouring for official maps is carried out with instruments such as the theodolite, level and clinometer. It is the work of trained surveyors, and since it must necessarily be a lengthy process it cannot be considered as part of military sketching.

Before attempting the explanation of various methods of contouring for field sketches, either with light portable instruments or without the use of any, the following terms, Horizontal Equivalent, Vertical Interval and Scale of Slopes, must be understood.

1. The Horizontal Equivalent—H.E.—is the horizontal distance, always referred to in yards on British maps, between two successive contours (Plate IV. 2). It will vary, therefore, in length according to the nature of the slope.

It should be noted that in contouring for field sketches the distance paced along the ground may be put down directly to scale on the map, any length on an incline being considered as equal to the same length "on plan." For anything but a steep slope the difference is negligible.

2. The Vertical Interval—V.I.—is the vertical distance, always in feet on British maps, between two successive contours (Plate VI. 2), and is constant for one map. The V.I. adopted in contouring depends upon the nature of the ground, the scale of the map, and the use to which it is to be put. A small V.I. would be impossible in mountainous country, and a V.I. of 100 ft. would be useless in flat country. Schemes for which every little rise in the ground is of

value would require a small V.I., but a small V.I., say 10 ft., on a small scale map would only result in confusion. The V.I. adopted should be a component of 100, and must be so when the 100 ft. (or metres) contours are already shown and intermediate ones have to be put in. 5 ft., 10 ft., 20 ft. and 25 ft. are the usual vertical intervals at which military sketches are contoured (Plates VII., VIII., IX. and X.).

(3) Scale of Slopes. A scale of slopes gives for a fixed V.I. the H.E., or distance between contour lines, for every degree of slope. Its construction is explained on page 36.

1. *Contouring with a Clinometer.*—The portable clinometer for military sketching is an instrument measuring vertical angles. The principle involved in its use is simple. Keeping the eye close to the ground through apertures in the instrument, one looks along the slope the angle of inclination or declination of which it is desired to find. A graduated arc showing degrees is kept stationary, and the difference between zero of the arc and the line of sight of the rising or falling ground gives the number of degrees of the slope. With the mirror clinometer the zero line of the arc is kept horizontal by means of a plumb weight, and with the Abney level a spirit level is used.

In contouring with a clinometer—or by any other method—it is preferable to work from the high ground to the low, as a better general impression of the conformation of the ground can thus be obtained. Beginning, then, with a commanding position, a level line or contour is established round the summit. If a spot level is shown on any available map this contour should be in relation to it, and all the contour lines accordingly figured from one datum—sea level. Next select prominent spurs and re-entrants—spurs for preference—down which the position of the contours at the selected V.I. are to be fixed. Set the sketch, and draw rays in alignment with the ridges of the spurs and centre lines of re-entrants (if not already marked by watercourses). When the direction of the ridge line of the spur bends, a new ray is drawn for the new direction.

The degrees of slope of the ridge of a spur, so far as it is more or less constant, is measured with the clinometer, and the distance

to the point observed as marking the limit of the slope is paced. From the scale of slopes for the V.I. adopted and the degree registered by the instrument (see page 37) the length of the H.E. is taken, and this length is marked off as many times as it will go in the length paced—each length marking the position of a contour. These points for the contours are traced round for a short distance on each side. If the last contour line does not reach as far as the distance paced, a little adjustment will be necessary in marking the first contour for the next change of slope. The process is continued along the spur for each pronounced change of slope, and when points have been established on the necessary number of spurs (and re-entrants) they are carefully linked together so as to indicate the formation of the intervening ground.

When other rising ground is met with, the process may be continued along suitable lines over such rises, or one or more contour lines levelled round them from points on the first slope, but when the ground consists of numerous hills and knolls it is best to obtain from one hill the degree of the slope to the summits of the others, and any other suitable points. The distance from one's own position to all these points is scaled from the sketch, and knowing the distances and angle of fall (or rise) the actual difference in height is readily calculated.* By this method heights can be obtained for points all over the ground, and the contour lines are drawn in by eye in accordance with them.

Another method of using the clinometer is to take the degree of slope from the top to the bottom of a hill, irrespective of changes in the nature of the slope. Knowing the degree of slope and the distance from the top to the foot as shown on the sketch, the "number of H.E.s" or contour lines for the selected V.I. is ascertained. The correct number of contour lines are then drawn in, and so spaced as to indicate as far as possible the changes in the character of the slope.

Whichever be the method adopted for using the clinometer, if

* The formula is:—V.I. $= \frac{\text{H.E.} \times \text{Degree}}{20}$. V.I. will represent the difference in height, and H.E. the distance between the points (see page 37).

time permits, greater accuracy can be obtained in correctly shaping the contour lines to the form of the ground if at least one contour be levelled completely round the whole area.

When there is no spot level to give the height above sea level, the lowest contour may be considered as the datum, and the remaining contours figured from this.

2. *Contouring with an Aneroid Barometer.*—An aneroid barometer (which can be obtained to show readings to 5 ft.) is most suited for rapid contouring, but should only be used in settled weather.

The relative heights of various parts of the ground are fixed by the readings of the barometer, which can be done as the map is being drawn. The contour lines are afterwards put in in conformity with the heights shown.

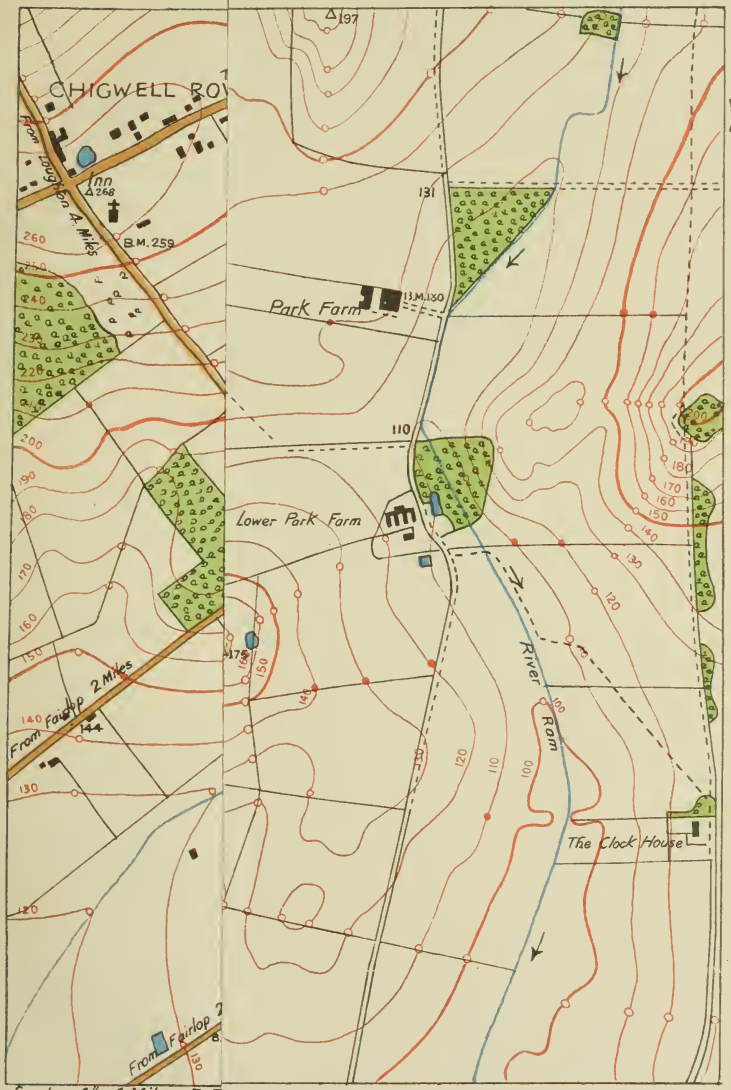
Before use the instrument should be set by some known height, and to avoid errors caused by changes in the weather it should be checked by other known heights whenever possible. If used to interpolate form lines between contours at a large V.I., it should be checked, and if necessary, re-set whenever an established contour is reached.

A short time should be allowed for the barometer to settle before taking the reading, and it should always be read in the same position.

3. *Contouring with a Level.*—A simple, though slow method of noting the rises in the ground 5 ft. at a time is by holding to the eye, quite level, a pencil or protractor. If a plumb line be attached to the arrow head on the protractor, the horizontality can be checked by noting if the string is in alignment with the 90° line. An assistant goes ahead in the desired direction, pacing the distance as he goes, and when his feet are aligned with the pencil or protractor the man halts and his position denotes a 5 ft. rise. Working down hill, if a 10 ft. rod be carried on the assistant's shoulder and the man with the level lies flat on the ground, a fall of 10 ft. can be marked each time.

This method of contouring, which is an accurate one, is best employed for interpolating form lines between contours at a large V.I. A pocket sighting level—a rectangular box about $\frac{3}{4}$ in. square and $4\frac{1}{2}$ in. long—may be used in exactly the same way, and is more

PLATE. X.



Scale 4" = 1 Mile. R.F. 100'·0" Trigonometrical Stations, Bench Marks & Spot Levels
500 400 300 200 100 plotted at a V.I. of 10'·0"
Scale of H.E. – V.I. 10'·0" which rises or falls of 10'·0" were recorded
1/60 1/50 1/20 1/12 1/10 1/8 form lines levelled from fixed points.

time permits, greater accuracy can be obtained in correctly shaping the contour lines to the form of the ground if at least one contour be levelled completely round the whole area.

When there is no spot level to give the height above sea level, the lowest contour may be considered as the datum, and the remaining contours figured from this.

2. *Contouring with an Aneroid Barometer.*—An aneroid barometer (which can be obtained to show readings to 5 ft.) is most suited for rapid contouring, but should only be used in settled weather.

The relative heights of various parts of the ground are fixed by the readings of the barometer, which can be done as the map is being drawn. The contour lines are afterwards put in in conformity with the heights shown.

Before use the instrument should be set by some known height, and to avoid errors caused by changes in the weather it should be checked by other known heights whenever possible. If used to interpolate form lines between contours at a large V.I., it should be checked, and if necessary, re-set whenever an established contour is reached.

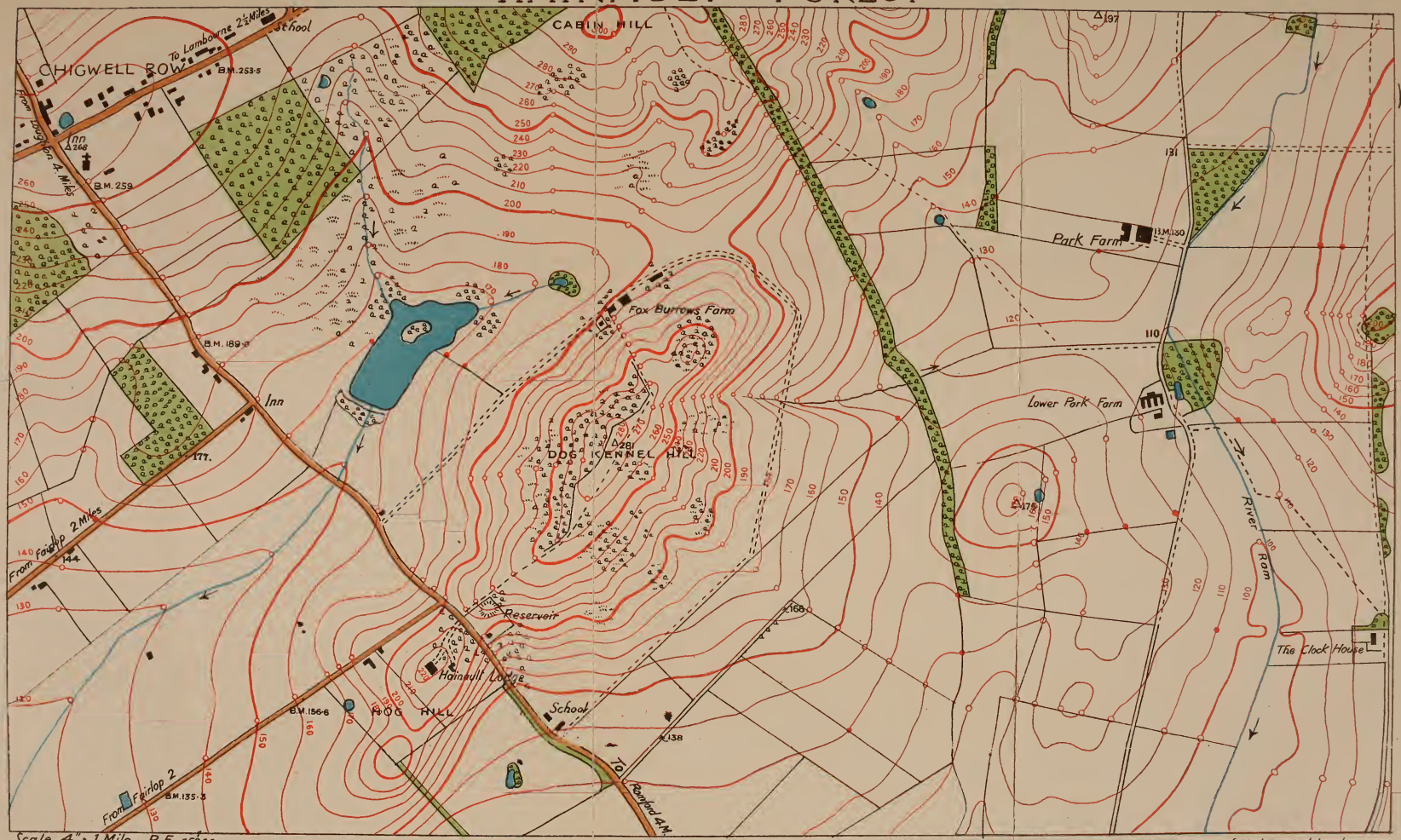
A short time should be allowed for the barometer to settle before taking the reading, and it should always be read in the same position.

3. *Contouring with a Level.*—A simple, though slow method of noting the rises in the ground 5 ft. at a time is by holding to the eye, quite level, a pencil or protractor. If a plumb line be attached to the arrow head on the protractor, the horizontality can be checked by noting if the string is in alignment with the 90° line. An assistant goes ahead in the desired direction, pacing the distance as he goes, and when his feet are aligned with the pencil or protractor the man halts and his position denotes a 5 ft. rise. Working down hill, if a 10 ft. rod be carried on the assistant's shoulder and the man with the level lies flat on the ground, a fall of 10 ft. can be marked each time.

This method of contouring, which is an accurate one, is best employed for interpolating form lines between contours at a large V.I. A pocket sighting level—a rectangular box about $\frac{3}{4}$ in. square and $4\frac{1}{2}$ in. long—may be used in exactly the same way, and is more

HAINAULT FOREST

PLATE. X.



Scale 4" = 1 Mile. R.F. 15840

500 400 300 200 100 0 500 1000 1500 Yards

Scale of H.E. - V.I. 10'-0"

1/60 1/50 1/30 1/25 1/20 1/15 1/12 1/10 1/8 1/6 Gradients

V.I. of Contours - 100'-0". Triponometrical Stations, Bench Marks & Spot Levels

Form Lines Interpolated at a V.I. of 10'-0"

-o- Denote lines on which rises or falls of 10'-0" were recorded.

-●- Denote positions of form lines levelled from fixed points.

accurate, as a small looking-glass in the box reflects a spirit-level whilst one looks through the apertures for some mark on the ground level with the eye.

Plate X. shows an area of country in which contours at a 10 ft. V.I. have been added to those of 100 ft. in this way. Working up and down hill from established contours, the lines of re-entrants and certain lines of fences already marked on the map are chosen, along which the rises and falls are to be taken. Spurs also are selected, and rays indicating their direction are drawn, or compass bearings taken. The lines selected for making the rises and falls are shown on Plate X. by small circles, each circle denoting a change of level of 10 ft.

When the position of one contour is fixed, with the level points at a similar height can be fixed on other parts of the ground, and these points are noted on the map according to the features they coincide with. The contoured map is completed by linking together all the established points according to the conformation of the intervening ground.

Contouring by such a method as that which has just been described trains the eye to realise how different formations of ground appear on paper, and leads to facility in contouring by eye. For the same object the protractor with plumb line may be used as a clinometer, and the method of contouring with that instrument followed. With the plumb line hanging from the arrow head and the edge of the protractor aligned with a slope, the difference between the degree marked by the weighted string and the 90° line shows the angle of the slope.

4. *Contouring by Eye.*—For field sketches, in which the chief object is not absolute accuracy, but to give in the least possible time a representation of the military value of the ground, contours can be put in by eye, and if contours at a large V.I. are already shown on the small scale published maps, it is an easy matter to put in with moderate accuracy any intermediate ones.

First discover the position of the highest contour on the ground that has been sketched, and from this point find out where the next

contour should run. Should any fold in the ground intervene, draw a light line to indicate its position. Consider the nature of the ground between the two established contours, whether it be uniform, concave, convex, or various slopes of different forms and guided by any lines drawn to show the intervening folds, draw lightly contour lines expressive of the formation of the ground seen between them. Trace these lines round as far as possible. This should be done in as many parts of the ground as may be necessary. Note the spurs and re-entrants—streams will usually indicate the correct positions of these—and then, having studied the ground from several points of view, the various contours can be linked together and drawn in with red or brown lines, or if in pencil with dotted lines.

This method simply means thoroughly studying and grasping the nature of the land, and knowing how the various formations of ground are represented on paper. Practice leads to sufficiently accurate results.

It should always be remembered that heights given on published maps for trigonometrical stations, bench marks and spot levels, if noted on the sketch in their correct positions, will help in placing the intermediate form lines.

Contours not instrumentally obtained are known as form lines. They should be very carefully and distinctly drawn in red or brown, and, if drawn with chalk, to ensure the necessary fine line the pencil should have a chisel edge. If in black, a chain dotted line should be used. If shown with contours obtained from published maps, to make a distinction they should be drawn more lightly.

It will help to make the map clearer if, with a small V.I., every 25, 50, or 100 ft. be accentuated (Plate IX.). Such accentuated contours might also be made darker according to their height above the sea level (Plate X.).

The contour lines must be figured, and if drawn in ink the figures should be in the same colour. The figuring should be neat, in continuous lines (Plate IX.), and sufficient lines of figures should be shown to enable the heights to be quickly read.

Minor formations of the ground, called underfeatures—slight

knolls or depressions—which are not shown by the V.I. adopted for the contours, may be indicated either by light dotted form lines interpolated between the contours, or in the case of such features as artificial mounds or cuttings by hachures. Such notes are important.

When time will not permit of form lines, however approximate, being drawn on a rapid sketch, and some idea of the shape of important features of the ground is necessary, little arrows, supplemented by notes, can be used, the arrow-head being always shown on the lower part of the ground (Plate XIV.).

Slopes and Gradients.

The following table shows how Infantry, Cavalry, Artillery and Transport are affected by different slopes. The nature of the ground—the foothold—should be taken into consideration.

1 in 20 (3°).—Road tractors can draw twice their own weight.
1 in 12 (5°).—A rise of 1 ft. in 4 yd. Possible for all arms.
1 in 10 (6°).—Transport moves with difficulty.
1 in 6 (10°).—Movement of Infantry in close formation is difficult. Cavalry can charge a short distance only up hill. Artillery can move for short distances only.
1 in 4 (15°).—Infantry can move in extended order. Cavalry can only move short distances. Extremely difficult for Artillery.
1 in 3 (20°).—Infantry in extended order. Cavalry moves with difficulty.
1 in 2 (30°) and steeper slopes. Infantry can ascend slowly, the men using their hands.

On contoured maps the gradients of roads and hills can be readily ascertained by means of a Scale of Slopes.

A Scale of Slopes or Gradients shows for a stated V.I. the H.E. or distance between contour lines corresponding to the degree of steepness in the rise of the ground. Since the V.I. is a fixed quantity,

for one map it must be obvious that the H.E. will vary in length only according to the degree of slope of the ground (see Plate IV. (2)). For a gentle rise it will be large ; for a steep slope it will be small.

If a scale is required solely for the purpose of measuring gradients from a contoured map it can be constructed by the following method. A gradient of, say, 1 in 15 means that for a rise of 1 ft.—V.I.—the horizontal distance travelled—H.E.—will be 15 ft., or 5 yds. Considering the gradients given above as affecting the different arms, and assuming a map contoured at a V.I. of 10 : 0″ for the gradient 1 in 20, or as it is more usually written $\frac{1}{20}$, to rise 10 ft. one will travel 200 ft. = 66 yds.—the H.E. For $\frac{1}{12}$—120 ft. = 40 yds. ; $\frac{1}{10}$—100 ft. = 33 yds. ; $\frac{1}{6}$—60 ft. = 20 yds., and so on. The Scale (Plate X.) is constructed by drawing a line and marking off to the scale of the map length of 66, 40, 33, 20 yds., etc. These are figured $\frac{1}{20}$, $\frac{1}{12}$, $\frac{1}{10}$, up to $\frac{1}{3}$. It is called Scale of Gradients, or Scale of H.E.—V.I. 10 : 0″. By transferring this scale to the edge of a piece of paper from the width between contour lines, the gradient at any part of the map is at once seen. With maps drawn to metrical scales, since both the V.I. and H.E. are shown in the same unit of measure, a scale of gradients can be very rapidly made.

A scale of slopes for use when contouring with a clinometer (page 30) is generally constructed in a different way, as the instrument records degrees of slope and not gradients, and for the degree of slope the corresponding length of H.E. is to be found. For the construction of such a scale the formula from which the necessary and simple calculations are made is based on what is known as the "Triangle of Reference." In this triangle one side—representing the slope of the ground—makes an angle of 1° with the base. To any scale the third side, representing the V.I., is shown by a line 1′·0″ in height, and perpendicular to the base. To the scale adopted for the V.I., the H.E. will be found to equal 19·1 yds., which in order to simplify calculations is called 20. From this the formula is deduced—H.E. $= \frac{\text{V.I.} \times 20}{\text{Degree of slope}}$.

Example: To construct a Scale of Slopes for a map to be contoured at a V.I. of 20 : 0″

$$\text{H.E.} = \frac{\text{V.I.} \times 20}{\text{Degree}} = \frac{20 \times 20}{3} = 133\times \text{ H.E. for a slope of } 3^\circ$$

$$\text{„ „} = \frac{20 \times 20}{5} = 80\times \text{ „ „ } 5^\circ$$

$$\text{„ „} = \frac{20 \times 20}{6} = 66\times \text{ „ „ } 6^\circ$$

and so on.

The Scale is constructed as before, and its use is explained in the description of contouring with a clinometer (page 30). A Scale of Gradients for a map already contoured can also be constructed, using the above formula if gradients be first converted to degrees. To convert such fractions to degrees of slope, it is only necessary to multiply by 60, which will give sufficiently accurate results up to 1 in 3. $\frac{1}{20}$, $\frac{1}{12}$, $\frac{1}{10}$ become 3°, 5°, 6°, and so on.

Visibility of Points.

To the trained eye contours not only give an accurate impression of the nature of the ground, but also show, with little calculation, covered approaches and what can and what cannot be seen from any given point. This, the knowledge of the visibility of points, may obviously be extremely useful in the preparation of any tactical scheme on paper. As a study, exercises in visibility and the practice of making sections are the most notable aid to the realisation of the "relief" of any area of country from its representation on plan—the contoured map.

Of the various formations of sloping ground much need not be said.

From the upper part of a convex slope little will be seen of the lower. With such slopes one may expect a considerable amount of dead ground (Plate VI., 2).

With concave slopes there is no dead ground, and a good field of fire will always be obtained (Plate VI., 3). The same might be said, though not with such certainty, of uniform slopes, for a very slight irregularity, unshown by the contours, might obstruct the view and cause a large area of the slope to become "dead."

The fall of the ground in valleys will nearly always be concave; spurs, on the other hand, are usually convex for their upper slopes, becoming concave towards the base.

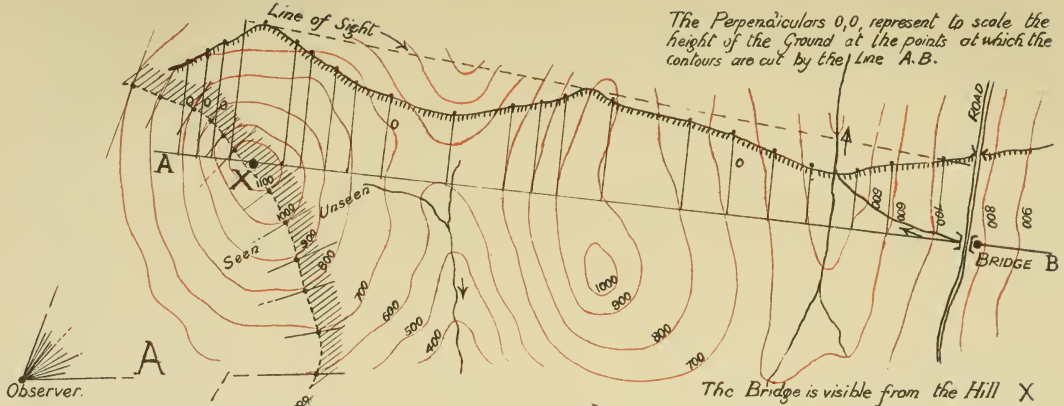
The foot of a hill is not easily seen from its summit. Summits normally are of flatter formation than the sides, and it is necessary to go forward to the brow or crest for the lower slopes to become visible.

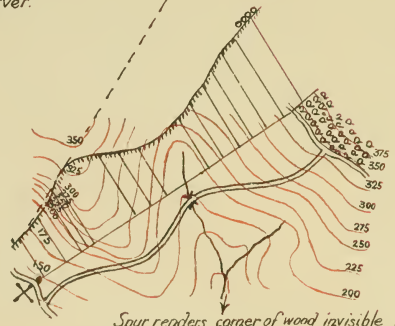
The question of the visibility of points is not so simple when there is an interrupted slope, where the ground rises and falls and there are intervening hills between the points under consideration.

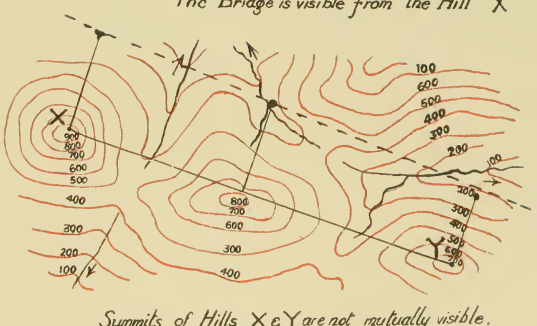
In the case of interrupted slopes—when the ground may be steep for some parts and flat for others—a little calculation may become necessary. Assume the side of a hill having a varied slope, and that it is desired to know if, from a selected position, a small copse higher up the hill will be visible. Assume the map to be contoured at V.I. of 20 : 0″, and the position to be on or near the 320 contour and the copse on the 480. Between the two positions there will be 8 contour lines. Measure the distance from position to copse—say 1200 yards. The distance between contour lines is the H.E. Divide 1200 by 8, the number of contour lines, and the H.E. would be 150× if the slope were an even one. If it were an even slope it would obviously correspond with the line of vision from position to copse, and they would be mutually visible.

On the edge of a piece of paper tick off lengths of 150×, figuring them 320, 340, 360, and so on, and place the piece of paper between the two points on the map. If it is found that any contour line is nearer to the selected position than the contour line of the same number as shown on the slip of paper, the ground is not only not an even slope—which would correspond with the visual ray—but at one point it has risen higher and obstructs the view. In other

VISIBILITY OF POINTS. PLATE XI







words, if a piece of string could be stretched tightly between the copse and position, the line in effect would be convex, and obviously the two points could not be mutually visible.

As it is possible to gauge approximately what the distance between contours should be for an even slope between two points, one can always tell by eye whether this distance is greater than the distance between the two contour lines next the lower of two positions, or less than that between the two contour lines next the upper position. In either of these cases it will be impossible to see one point from the other.

To grasp thoroughly the question of the visibility of points, and to be able to answer with assurance any question concerning them when studying a map, it is advisable to practice making "sections."

A section taken through a hill or series of hills tells us what would be seen from one side if a vertical cut in the earth's crust were made with a huge knife and the ground between the spectator and the cut removed.

Plate XI.A shows an area of country with the contours drawn, and above is the section that would be seen if a knife were to cut vertically down along the line A.B., which is the line joining the points, the mutual visibility of which it is desired to discover.

Sections are drawn as follows:—At the points where the line A.B. cuts the contours perpendiculars to it are erected. The height of each of the contours is then marked off on the perpendicular erected from it. This can be done to any scale, but it should be larger than that used for the map, otherwise, except in very mountainous country, the rises and falls would be insufficiently pronounced. Join the points together, and a fairly accurate representation of the relative heights of the ground will result. Sections need not be drawn on the map. A piece of paper may be used, having one edge on the line A.B., and upon this the perpendiculars and section line are drawn.

When the V.I. of the contours is a large one, say 100 ft., the exact height of a hill can only be guessed at. The highest contour line may show 800 ft., but the hill might rise to 890. In such cases

if no figure shows the height of the actual summit one can only draw in the top of the hill in accordance with the general slope of the ground where it is definitely fixed by the contours.

Sections need not always be drawn. If the two points in question are obviously higher than any intervening ground they must be mutually visible.

If there are any doubts draw a line joining the two points and erect perpendiculars on those contours only which might render one point invisible from the other. These perpendiculars, drawn to scale, are quite sufficient to show what is required. (Plate XI.C.)

A method of ascertaining the visibility of points which does not necessitate drawing upon the map is that known as "Comparative Gradients." The following is an example. On a map it is desired to know if two points, X, 750 ft. high, and Y, 640 ft. high, are mutually visible. Between them a possible obstacle, a hill, W, rises to 700 ft. Scale off the distance from X to W. It is 2000 yds. An imaginary line joining X to W would correspond to the line of sight, and this line would drop 50 ft.—the difference in height between X and W—in 2000 yds. The "gradient" will be $\frac{50}{2000 \times 3}$ (to bring to feet) $= \frac{1}{120}$. From W to Y the distance is 2700 yds. The difference in height is 60 ft. The "gradient" of the line of sight will be $\frac{60}{2700 \times 5} = \frac{1}{135}$. Since the line of sight from X to W is steeper than that from W to Y, a line joining the three summits would be concave in outline, and obviously the hill W cannot obstruct the view.

Of the various methods devised to determine the visibility of points, the method of sections is the one that has the advantage of not only showing if two points are mutually visible, but also of showing the general nature of the slopes and at which point the ground will again come into view.

To discover how much of a hill or spur will be seen by an observer at a given point, it is only necessary to imagine the position

of the observer as being that of a powerful light. Lines drawn from the position as tangents to the contour lines show which part of the hill would be in shade. The part in shade is that which would not be seen (Plate XI.).

The theory of the visibility of points applies to the ground when devoid of woods and trees. The position of woods can be noted on maps and may be accounted for, but such obstacles as hedges heavily lined with trees cannot be foreseen.

4. LETTERING.

Types of Lettering.

The legibility of any printing is the first consideration. It must be placed so that it will neither interfere with the detail of the map nor in any way confuse the drawing. Lettering may be in upright or sloping block letters, or, for minor features and notes, italics. Uniformity in height and spacing is desirable, and until proficiency is acquired it is advisable to rule parallel lines a distance apart equal to the height of letters required and to use them as a guide. Rapidity will come with practice.

A useful guide in hasty lettering will be found in the protractor, which is placed on the sketch with one edge in the position in which it is desired to print, thus keeping the downward and horizontal strokes in one straight line. If printing in italics, the "tails" to such letters as *g* and *y* are added when the protractor is removed.

Plate XII. shows types of lettering and should be copied.

System of Lettering.

All lettering should be horizontal, with the exception of the names of rivers, roads, railways, etc. It should be so placed as to leave no doubt as to which part of the map it relates. It should extend across an area—e.g., a common—and for small features should read from the right side of the object referred to. If any doubt exists draw a line and arrow-head to the object.

A descriptive heading in block letters at least $\frac{1}{8}$ in. in height must be printed on every sketch. The names of principal features, towns, villages, etc., should be in block letters, and all other notes may be in smaller block letters or italics, which are easily and rapidly formed (Plate VII.).

PLATE XII

EXAMPLES OF LETTERING

BLOCK LETTERS

&

Italics are used for Military Field Sketches

LEGIBILITY IS ESSENTIAL

HEADINGS & CHIEF NAMES IN BLOCK LETTERS

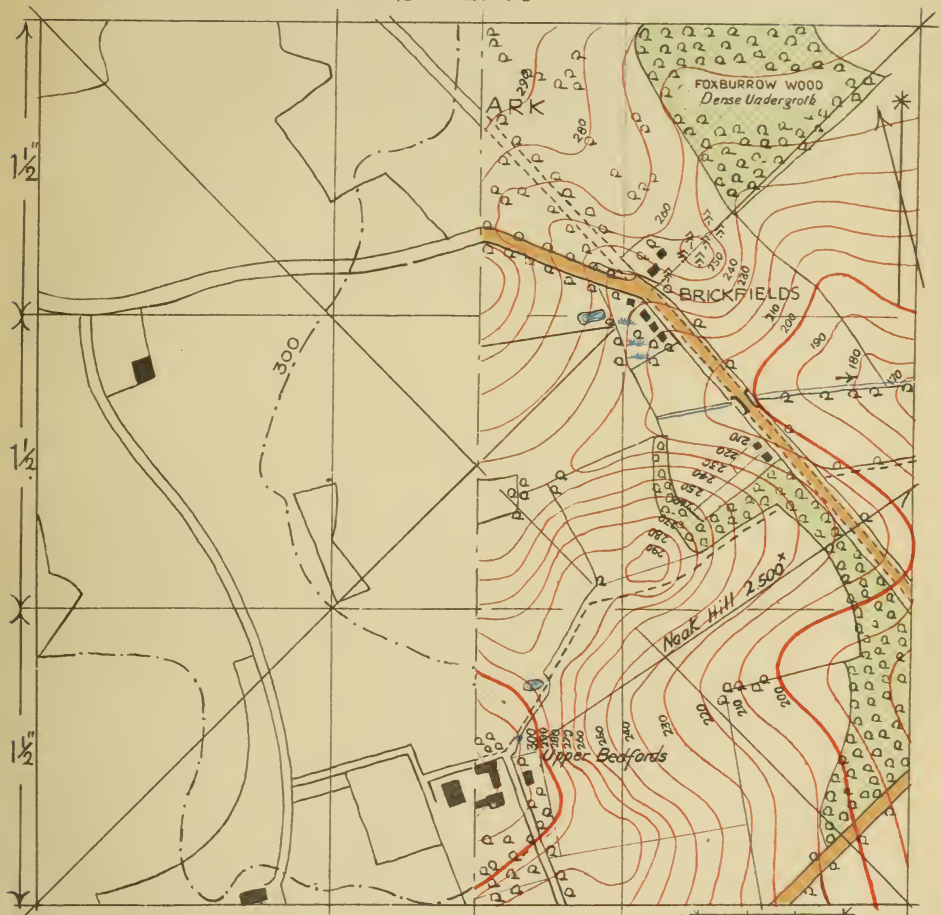
&

Descriptive Notes in Italics

RAPIDITY COMES WITH PRACTICE

MAP ENLARGEMENT

PLATE XIII



A. Area of Country ¾ miles square as shown on 1" Ordnance Map.

B. One half of Enlargement of A. Scale 6" = 1 Mile.

C. One half of Enlargement Completed on the Ground.

Roads leaving the map on the left side and bottom are marked "from," those on the right side and top "to," with the name of the nearest town or important village and the distance. This also applies to railways.

The name of the author of the sketch, with rank, regiment and date, must be printed in the bottom right-hand corner.

5. MAP ENLARGEMENT.

The Object.

It has already been pointed out that to make a map in unmapped country would take a considerable amount of time, and would mean both accurate instruments and skill in using them; it is, in fact, work which must be left for specially trained men, work which but few officers who are not specialists will be called upon to attempt.

The occasions will be rare when a map, though perhaps on a very small scale, is not available on the scene of operations. It will then be necessary to correct and to enlarge maps which are not up-to-date, maps which, because of their small scale, do not show enough, or the right kind of information, or permit of the disposition and movement of troops being shown upon them, and to supplement the enlargement—on the ground—with such further detail as may be necessary for the tactical scheme in hand. The small scale published maps usually are most deficient in representation of the varying levels of the ground, for contours at vertical intervals of 100 ft. or 20 metres do not, except in mountainous country, give an accurate idea of the possibilities of the ground.

The positions of important features, more or less accurately placed, are given by the enlargement, and the intervening detail can usually be filled in by eye. If the objects which are definitely fixed and easily recognisable are far apart, it may sometimes be necessary to fix intervening points with the prismatic compass by the method known as triangulation, and described later in the explanation of the use of that instrument.

Methods of Enlarging.

Over the area on the map which it is desired to enlarge a series of rectangles are drawn. Their size will vary from 1 in. to $\frac{1}{4}$ in.

square, according to the amount of detail on the map. On the paper on which the enlarged sketch is to be made rectangles, the sides of which are proportionately larger than those on the map—according to the new scale—are drawn, and the detail on the map, taken rectangle by rectangle, is put in by eye on the new sketch (Plate XIII.).

All maps are drawn with the top to the North, but a sketch for a tactical scheme should have the top facing the direction of the enemy. When the position of the enemy is known, therefore, the rectangle must be drawn on the map accordingly. A line is drawn to indicate the direction of the enemy's advance, and the sides of the rectangles are drawn on the map parallel and at right angles to this line.

Do not attempt to enclose the area to be enlarged with a marginal line, and then divide the space enclosed. It is a tedious operation, and unnecessary. Draw the rectangles to the size found convenient, and if they extend beyond the area required do not draw all the detail contained.

It is not necessary that the rectangles be square, but if the enlargement is being made on Army Book 153, which is ruled in $\frac{1}{4}$ in. squares, lines $\frac{1}{4}$ in. apart on the map will be represented by every fourth or sixth line on the book according to whether the map be enlarged to a scale of 4 in. or 6 in. to the mile and from the 1 in. scale Ordnance. If from the $\frac{1}{2}$ in. scale Ordnance, every eighth or twelfth line would be marked.

If the enlargement is being made on blank paper, mark off on the edge of a piece of paper or card the side of one rectangle on the map three, four, six, or any number of times according to the new scale for the enlargement. This will be the length (or breadth) of one side of the rectangle for the enlargement, and the network of squares is completed accordingly.

With the service protractor squares on both the map and paper on which the enlargement is to be made can be readily set out. Assume the map from which the enlargement is being made to be to a scale of 1 in. to 1 mile, and the enlargement to be made to 4 in.

to 1 mile. Using the scale of 1 in. to 1 mile on the edge of the protractor, tick off on the map, say, every 500 yds., and rule squares accordingly. On the paper on which the enlargement is to be made, using the scale of 2 in. to 1 mile, tick off every 1000 yds. (equal to 500 yds. for a scale of 4 in. to 1 mile) and complete the squares.

If a sketch is to be made to a scale which is not a multiple of the scale of the map to be enlarged a little calculation may be necessary. In such cases, e.g. foreign maps enlarged to an English scale, one must work with the R.Fs.

Example :—An enlargement to a scale of 6 in. to 1 mile—R.F. $\frac{1}{10,560}$—is to be made from a map the R.F. of which is $\frac{1}{80,000}$ Squares of $\frac{1}{4}$ in. side are drawn on the map, but as 80,000 is not a multiple of 10,560 the following calculation must be made to find the size of the square for the enlargement.

For a map with R.F. of $\frac{1}{80,000}$ the side of the square is $\frac{1}{4}$ in.

" " " $\frac{1}{80,000}$ " " " $\frac{80,000 \times 1}{4}$ in.

" " " $\frac{1}{10,560}$ " " " $\frac{80,000 \times 1}{10,560 \times 4}$

$= 1 \cdot 89$ in.

Squares of $1 \cdot 89$ in. side must be drawn for the enlargement.

The service protractor could have been used for the above, and when working from foreign maps having a R.F. for which a scale of yards is shown on the protractor. In the previous example, an enlargement from $\frac{1}{80,000}$ to 6 in. to 1 mile, using the protractor, squares of, say, 600 yards side to the scale of $\frac{1}{80,000}$, could have been marked off on the map and on the sketch-book squares of 1800 yards side to the scale of 2 in. to 1 mile (equal to 600 yds. for a scale of 6 in. to 1 mile).

It should be noted that for the network of rectangles on the

small scale map a sheet of celluloid with $\frac{1}{4}$ or $\frac{1}{2}$ in. squares drawn on may be used. This is placed over the area to be enlarged, pinned in position, and will save both time and marking the map.

Diagonal lines can be drawn to any or all the rectangles of the map and enlargement with little trouble, and they will obviously help to fix more correctly the detail of each square.

When the squares have been completed by any of the above methods the various features of the map are now transferred square by square and as accurately as possible to the enlargement.

If the area of country to be enlarged is considerable, and the work to be carried out by more than one, do not make several enlargements—one only of the whole will be more accurate. This can be cut into parts and the different areas covered accordingly. The drawings can be again pieced together on the completion of the work and finished up by one hand.

It must be remembered that corrections may have to be made when the ground is gone over, so everything should be drawn lightly and no colour used. Put on the contours very accurately (in pencil, with a chain dotted line), and any heights that may be figured, and to assist in showing more fully the various levels every little stream should be noted.

Omit lines showing parish and other boundaries, and do not show the stippling by which on Ordnance maps private parks are shown, though their boundary fences should be drawn in. Whilst, generally, anything that is obviously of no military value should be omitted, features that are likely to help in fixing other points when on the ground should be shown.

Buildings and roads are already exaggerated in size on small scale maps, and should not, therefore, be enlarged much, if at all.

The scale for the enlargement must be drawn at the foot of the sketch. The north point must be shown in the top right-hand corner—a star indicates the line of true north, and the direction of the magnetic north is shown by an arrow-head (Plate III., 19).

As the sketch is drawn with the top towards the enemy the correct position of the N line is obtained by noting the angle made

by this line with the line of the enemy's advance as shown on the small scale map.

If it is desired to make an enlargement of a length of road, it can be done by the system just described, dividing the road up into sections, squaring each one and enlarging section by section as for an area of country, and piecing them together, if more than one sheet has been used, afterwards.

It is obvious that, should it be necessary, maps could be copied or reduced by the methods used for enlargement.

Instruments and Materials.

For field sketching, and especially filling in the details of an enlargement, elaborate instruments are not only unnecessary but are an encumbrance. Small pocket dividers may be carried if desired, but distances can quite well be taken from the scale by ticking off on a piece of paper. The service protractor should always be carried, and an H.B. or F. pencil and a rubber are of course essential. Anything softer than an H.B. (which MUST be kept sharply pointed) rubs and spoils the clearness of the sketch.

Blue chalk is used for water, light brown for roads, green for woods, and red or brown for contours—brown of a darker shade than that used for roads—is essential to avoid confusion when trenches are being shown. Red and blue chalks are used to show one's own and enemy troops and entrenchments. The chalks are used lightly, as already explained for the various conventional signs.

If the map is to be finished in ink, either for purposes of reproduction or in order that it shall be more permanent, only good waterproof ink should be used. Never use a copying-ink pencil.

Smooth paper, such as that supplied with Army Book 153, is the best to work on, and the map-sketcher should become accustomed to the use of this book, which must be carried in the field.

A prismatic compass should be carried, but any elaborate instrument for measuring heights is quite unnecessary for field sketching when rapidity is essential.

If mounted a cavalry sketching board will be found a convenience.

Filling in the Detail.

Before setting out to fill in the additional information on the enlarged sketch it is essential to know definitely for what object the map is being made. Only by appreciating the problem for which the sketch is required will the sketcher be likely to obtain all the information which is necessary, and to omit anything that is not relevant to the military purpose of the map.

Choose the highest part of the ground to walk or ride over, ground from which most of the country to be mapped can be seen. Arrange the tour round so that the greatest area of ground can be covered in the shortest time, and do not stop to mark every little feature. Halt when there are several features which can be put in at once, always remembering to "set" (see page 63) the sketch with the ground before drawing anything.

Objects are put in by comparison with fixed points on the enlargement which are identifiable on the ground. The position of features which cannot thus be put in by estimating by eye or by pacing must be obtained with the prismatic compass already referred to and by a method explained later.

In pacing long distances it is simpler to pace the normal length rather than pace yards. Knowing the exact length of one's pace, a comparative scale showing paces for the R.F. of the map can be drawn and will save time converting paces to yards. If mounted a time-scale should be drawn for the scale of the map.

Lines of fences, woods, etc., and the direction of roads and streams can be ascertained by "setting" the sketch—by compass or any fixed objects—and drawing rays aligned with the required features.

Enough has been said in describing the conventional signs to show how they must be drawn in. Particulars of the nature of the ground, crops, etc., will be given by note. All fences need not be drawn ; their existence and nature can be stated by note, but fences and ditches which are likely to be used for cover or fire positions should be marked. Knowledge of the use to which the sketch is to be put will enable one to decide what details to omit and what to put in.

Buildings should be shown solidly with the pencil, as they are

distinctive objects by which the country can be recognised from a distance, and similarly all roads should be shown by firm lines (Plate VII.).

The ranges to any commanding position overlooking the area mapped but not on the sketch should be given, and also the ranges to ground commanded by prominent points on the map. The direction of the commanding position or of the ground commanded by a position is shown by a line with a tick on one side only (Plates XIII., XVII. and XXXII.).

Contour or "form" lines will of course be shown. The representation of the levels of the ground is perhaps the most important information that can be added to an enlargement.

The method of showing the hill features has already been explained in the description of contours. Notes only may sometimes show a valuable fire position or an advance under cover; but, whilst notes of this nature are important, it must always be remembered that it is the duty of the map-sketcher to give information, and not to solve the tactical problems himself.

Filling in the details of an enlargement should be an exercise in training the powers of observation, and having completed the map the sketcher should be able to guide, if necessary, a night attack over the ground.

Completing the Sketch.

The drawing should be made in clean firm lines. It should be workmanlike, clear, easily read, and not overcrowded with unnecessary detail.

A sketch should always be placed on the paper to leave a margin of not more than $\frac{3}{8}$ in. at the top for the heading, as all the available space is needed at the bottom of the sketch for notes.

The heading, stating the purpose of the sketch, and all other necessary lettering must be neatly printed, and the sketch must be signed, giving rank, regiment and date at the bottom right-hand corner. The top left-hand corner should always be left free from

notes and printing, as this is the point of attachment for any accompanying report or paper.

Notes, which should be brief and relevant, are of great value, as are sections of likely fire positions, and small sketches (with dimensions) of such features of tactical importance as bridges. These should all be shown under the sketch, tabulated, and with reference letters or figures (in a small circle) in front of them and on the portion of the sketch referred to (Plate XVIII.).

The V.I. adopted for the contours must be stated under the scale, and if the sketch has been made very hurriedly and is not reasonably accurate a note must be added to that effect.

6. SKETCHING BY EYE.

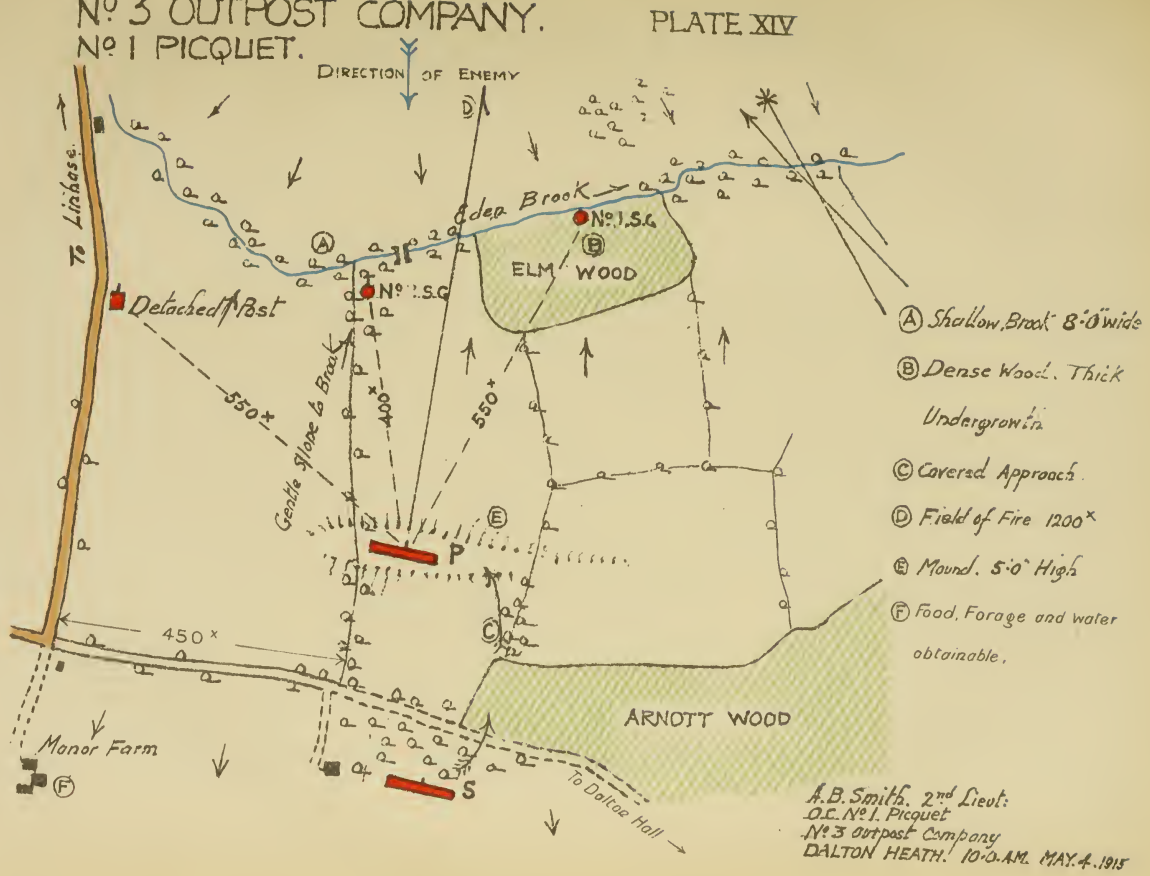
Sketches of Positions.

The term eye-sketching is used to distinguish from map enlargements sketches made by eye on blank paper and without the use of any instruments. It may often happen that there has been no time to enlarge from a small scale map, and the sketch must be made with the least delay possible. This particularly applies to sketches which have to be made of one's own position or positions taken up by the enemy. In such cases the roughest of drawings may be of use.

The drawing also may have to be made under such conditions that the sketcher must neither move from his position nor expose himself. Much of the detail will have to be put in with the aid of field-glasses, and rather than choose a position from which he can observe most of the ground the sketcher must select a suitable background and take such cover that he himself shall be free from observation.

The value of an enlargement from a small scale map lies in the fact that a number of definite objects which are identifiable on the ground are correctly placed, and working from them other details can be easily filled in. These fixed objects might be called "Ruling Points." In sketching by eye ruling points which form the framework of a sketch must either: (1) be dispensed with, or (2) obtained by other methods.

Whichever method be adopted, and whether standing in one fixed spot or moving freely over the country, if satisfactory results are expected a little calculation is necessary at the outset. The area of country that is to be shown must be decided upon and a suitable scale selected, in order that the sketch shall be kept within the limits of the paper. The country should be carefully analysed, and before


No 3 OUTPOST COMPANY.
No 1 PICQUET.
PLATE XIV
DIRECTION OF ENEMY
To Linhase.
Eden Brook
No 1 S.C.
No 2 S.C.
ELM WOOD
Detached Post
550x
400x
550x
Gentle Slope to Brook
P
450x
Manor Farm
ARNOTT WOOD
To Dalton Hall
A Shallow Brook 8·0 wide
B Dense Wood. Thick Undergrowth
C Covered Approach
D Field of Fire 1200x
E Mound. 5·0 High
F Food, Forage and water obtainable.
A.B. Smith. 2nd Lieut:
O.C. No 1. Picquet
No 3 outpost Company
DALTON HEATH. 10·0 AM. MAY 4. 1915

drawing any lines on paper the sketch must be always held correctly "set" with the ground.

(1) A man who has practised visualising country from a map, or one who, after studying the ground, can form an accurate impression of its appearance on paper, will be able to sketch fairly correctly a small area of country without any fixed points to guide him. Still better practice is that of examining the ground and jotting down on paper a sketch of what is seen. Whilst still on the site the rough sketch-map is then compared with and corrected by a reliable map of the district. Experience in map enlargement will also lead to greater competence in eye-sketching (Plate XIV.).

(2) If time will permit, and it is not necessary to remain under cover, the following method may be adopted. A central position, preferably on high ground, is chosen and the sketch book is placed on the ground. The north point is then put on with the compass, the top of the paper either facing north or, if known, the direction of the enemy. Next, the position chosen is marked in the centre of the paper. The sketcher lies on the ground, and without disturbing the book (if moved it can be set again by the compass) moves round, drawing straight lines or rays to prominent surrounding objects by means of the protractor or a straight stick which is pivoted on the central point and aligned on each chosen object in turn. The distance to each selected object is either paced or estimated by eye and drawn to scale, the name of the object or a conventional sign being shown at the end of the line.

On the paper will now be found a series of fixed points such as might have been obtained, though more accurately, from an enlargement. The detail is filled in and the sketch completed.

If a central position cannot be chosen, e.g. the case of a picquet commander wishing to make a map of the ground in front of him whilst remaining under cover, the rays can be drawn from a spot at the bottom of the paper, and the framework would resemble a range card made for the defence, with which it might well be combined.

The area of country sketched must be easily identified on a small scale map. The names of any towns or villages in the vicinity, with the

distances to them, must be shown on roads that appear on the sketch, and if there are no easily identified features, such as roads, woods, or important buildings, a ray or rays showing the direction and distance of some important distant features should be drawn.

Road Sketches.

If an enlargement is not possible, a sketch may be made of a road by the method of drawing rays just described. The sketch book is held so that the general direction of the road will run up the centre of the paper, and the north point is drawn on.

Standing at the starting point on the road a ray is drawn aligned on a distinctive object—a tree—at the first bend. The distance to the tree is paced and drawn to scale. It is now necessary to look back, and when the line just drawn is aligned on to the starting point the sketch is "set" with the road. The protractor is now pivoted on the position marked on the paper for the tree and aligned on the object—a gate—at the next bend in the road, and the distance to it is paced and drawn to scale.

On reaching the gate the sketch must be again set by looking backwards and aligning on to the tree. When set a new ray is drawn to the next bend, and so on until the road sketch is complete, the detail on each side being filled in as the distances are paced.

This method of making a road sketch is known as traversing. For the completion of the sketch particulars are given in the description of traversing by compass, etc. (page 102).

Traversing with the straight-edge may be adopted in making trench plans and also for billeting sketches when the direction of all roads can be easily obtained by this method, and particulars of the buildings, possible alarm posts, etc., put in, as the distances along the road are paced. On Plate XV. the "rays" necessary for the sketch are shown in red.

7. MILITARY SKETCHES.

General Principles.

It is only when warfare has been conducted continuously over one area that military maps can be supplied to such scales as will show the information necessary to meet all needs.

The regimental officer is called upon not to make military maps, but to supplement them by military sketches of limited areas—enlargements, eye-sketches, or traverses, such as can be made either with the simplest of instruments or without any at all. He must in addition be able to correct and add such information to the published maps as will assist the Intelligence Staff in the field.

The methods by which military sketches are made has been fully explained. The actual method to be adopted for any purpose will depend upon circumstances; given time for a relatively large area, where accuracy is essential, an enlargement is best, whilst for a small area, when speed is most important and the chief consideration is to show the disposition of troops, an eye-sketch will suffice. Generally speaking, however, any published map that is available should be made the basis of any further work.

For successful military sketching two things are of paramount importance, rapidity and relevancy. Rapidity will be attained if the sketcher is thoroughly conversant with scales, conventional signs, the methods of showing hill features, and the technique of sketching. Relevancy comes from a knowledge of the characteristics and functions of the various arms and an intelligent grasp of the object for which the sketch is being made.

The scales to be adopted and general information necessary for all military sketches has been dealt with elsewhere. Below is given the special information which should be unmistakably shown on sketches for the objects stated, and on Plate XVI. are shown the recognised symbols by which much of this is drawn.

Special Information.

This may be considered under the following heads :—

(1) *Defensive Position :—*

a. Best positions for infantry and artillery, also supports, reserves, cavalry, etc.—Referred to by note.

b. Field of fire and ranges to important points.—Lines showing direction and distance.

c. Favourable lines for enemy's attack.—Arrows in blue.

d. Possible positions for enemy's guns.—Referred to by note.

e. Positions from which enemy can direct effective fire.—Referred to by note.

f. Best line of retreat.—Arrows.

g. Best lines for counter-attack.—Referred to by note.

(2) *Enemy's Position :—*

a. Position of enemy's troops where ascertained.—Conventional signs for different arms in blue.

b. Best line of attack.—Arrows.

c. Obstacles.—Conventional signs and notes.

d. Good points for enfilade fire.—Referred to by notes.

e. Artillery positions.—Referred to by note.

f. Good observation posts.—Referred to by note and marked O.P.

g. Prominent points likely to guide attack by day and (especially) by night.—Enclosed in squares and referred to by note.

(3) *Outpost Position :—*

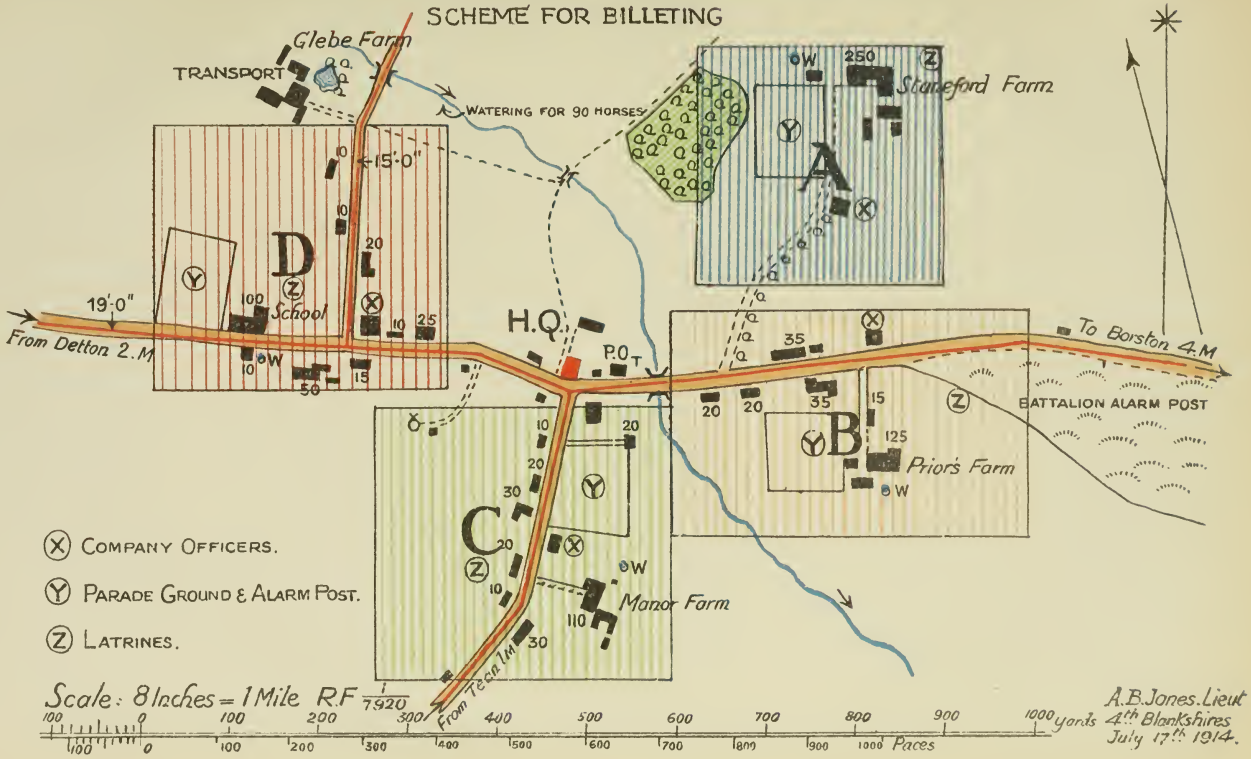
a. Position of supports, picquets, sentry groups and detached posts, with distances between same.—Conventional signs for troops. Positions by day in red, by night in blue.

b. Direction of and distances to neighbouring picquets and supports.—Arrows.

STONEFORD

SCHEME FOR BILLETING

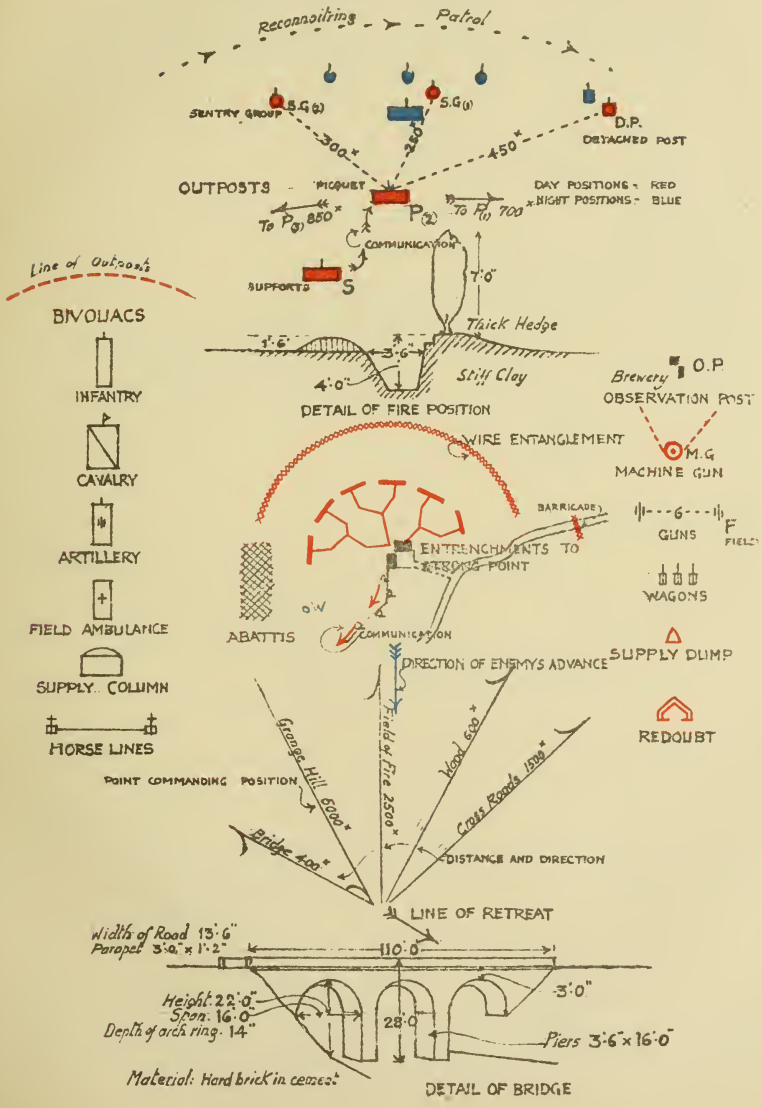
PLATE XV.



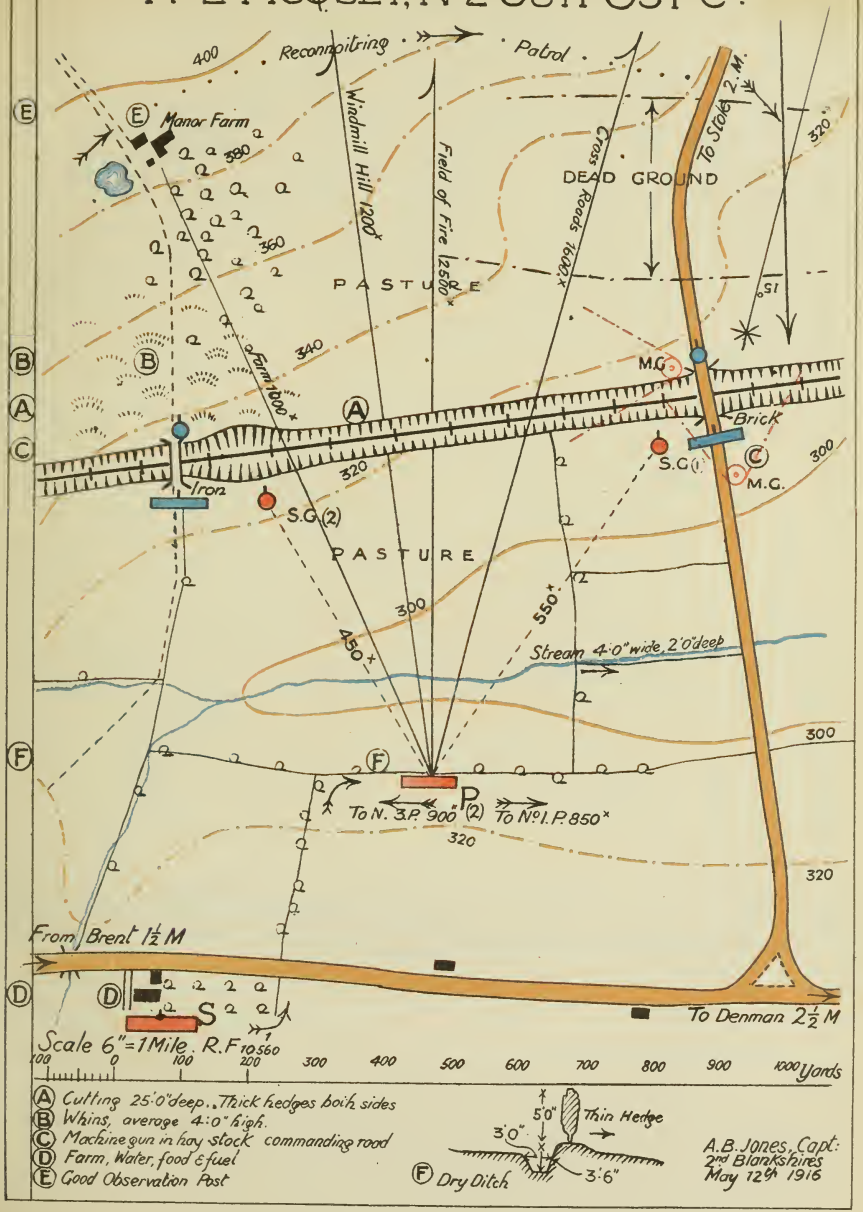
A.B. Jones. Lieut
4th Blankshires
July 17th 1914.

MILITARY SKETCHES PLATE.XVI.

INFORMATION SHOWN BY SYMBOLS



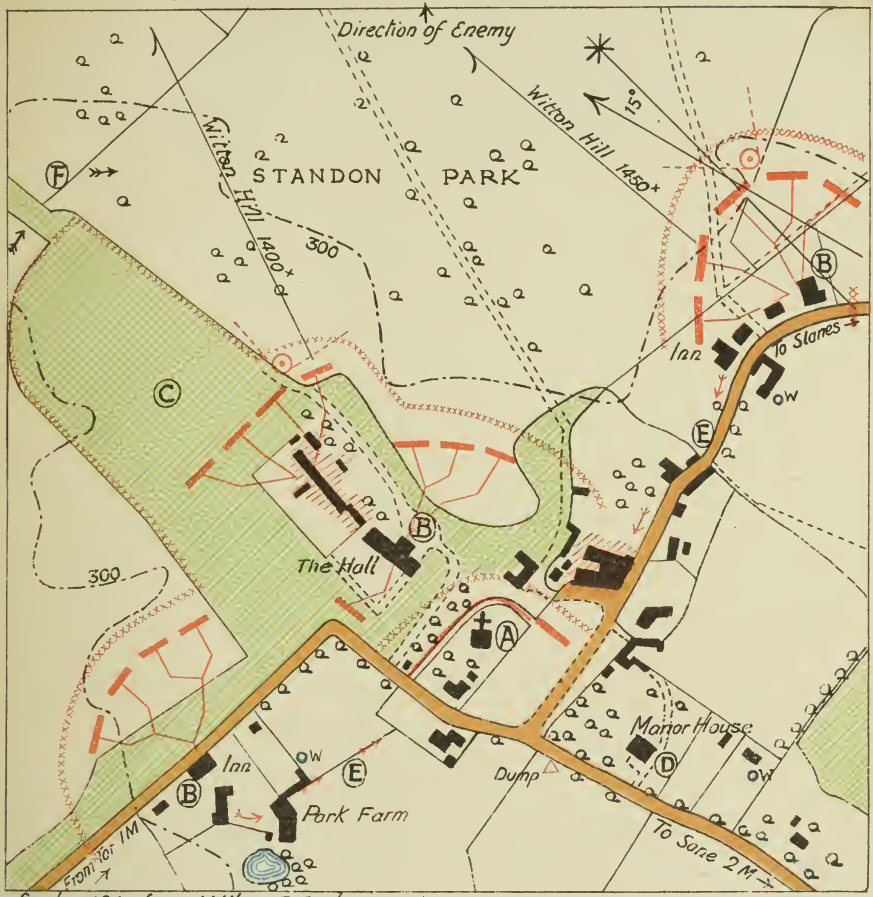
Nº 2 PICQUET, Nº 2 OUTPOST Coy



A.B. Jones, Capt:
2nd Blankshires
May 12th 1916

DEFENCE OF A VILLAGE

PLATE XVIII.



A . Central Keep
B . Strong Points - good cellars
C . Open Wood - Undergrowth cleared
D . Dressing Station
E . Ditch suitable for communication
F . Reconnoitring Patrol.

Name & Rank
Regiment
Date.

c. Position of machine guns, showing limit of angle of traverse.—Conventional sign and dotted red lines.

d. Direction of reconnoitring patrol.—Dotted lines and arrows.

e. Best line of retreat.—Arrows.

f. Suitable approach from supports to picquet.—Arrows.

g. Field of fire and ranges to points enemy will pass in advancing.—Lines showing direction and distance.

h. Good observation posts.—Referred to by note and marked O.P.

i. Ranges to important points commanded by picquet and not shown on sketch.—Lines showing direction and distance.

j. Probable direction of attack.—Arrow in blue.

(4) *Artillery Position* :—

a. Proposed position of guns and wagons.—Conventional signs.

b. Approaches : concealment and nature of ground.—Referred to by note.

c. Natural screens.—Referred to by note.

d. Observation posts.—Referred to by note and marked O.P.

e. Line of advance from position.—Arrows.

(5) *Defence of a Village* :—

a. Buildings to form strong points.—Entrenchments shown, and reference to construction of buildings made by note.

b. Keep.—Entrenchments shown, and reference to construction of buildings made by note.

c. Obstacles, natural and artificial.—Conventional signs and notes.

d. Road barricades.—Conventional signs.

e. Communication between keep and strong points.—Arrows in red.

f. Demolitions.—Conventional signs.
g. Field of fire.—Line showing direction and distance.
h. Machine guns, showing limit of angle of traverse.—Conventional sign and dotted red lines.
i. Direction of reconnoitring patrol.—Dotted line and arrows.

(6) *Routes :—*
a. Roads: width, surface, gradients affecting rate of march.—Referred to by note.
b. Nature of fences.—Referred to by note.
c. Ease of deployment.—Referred to by note.
d. Bridges.—Referred to by note, with figured sketches.
e. Ground commanding and commanded by road.—Lines showing direction and distance.
f. Possible ambuscades.—Referred to by note.
g. Camping grounds.—Areas shown by enclosing line, and referred to by note.

(7) *Billets :—*
a. Number of men per house.—Figured.
b. Post offices, telegraph, important buildings, and stabling.—Named and referred to by note.
c. Allocation of quarters to each company or unit.—Enclosing line and colour, with name of company or unit.
d. Headquarters.—Shown in red.
e. Officers' quarters.—Referred to by note.
f. Transport.—Named.
g. Parade grounds and alarm posts.—Shown by enclosing line, and referred to by note.
h. Positions for latrines.—Referred to by note.
i. Water supply and watering.—Conventional signs, and referred to by note.

(8) *Bivouacs :—*
a. Selected area (coloured) and accommodation for each company or unit.—Symbols for the various arms.

b. Nature of soil, ground and drainage.—Referred to by note.
c. Approaches.—Arrows.
d. Means for protection.—Outpost line, dotted red.
e. Position for headquarters.—Shown in red.
f. Horse lines.—Conventional sign.
g. Positions for latrines.—Referred to by note.
h. Alarm posts.—Shown by enclosing line, and referred to by note.
i. Shelters and materials for shelters.—Referred to by note.
j. Water supply and watering.—Conventional signs, and referred to by note.

8. MAP READING.

Proficiency in Map Reading.

The best practice to enable one to become proficient in map reading is map making. To read maps it is necessary to understand the scales to which they are drawn ; to know the conventional signs with which the natural and artificial features of the country are represented ; and, most important of all for military purposes, it is necessary to be thoroughly conversant with the methods of representing hill features and to be able to read from contour lines and other methods of showing heights the formation of the ground.

In mapping any tract of country one sees how formations of the ground—length, breadth and height—are shown on the flat surface of the paper, i.e. "in plan." This once understood, obviously every other map or "plan" will be more readily seen in relief, and to grasp the "third dimension" from a flat drawing is invariably the part of map reading which presents the greatest difficulty. Proficiency, then, in the reading of maps is best and most permanently obtained by map sketching.

Constant practice in visualising country is invaluable. Before going over any area of ground look up the route and try to visualise the nature of the country with all its features, and what will and what will not be seen from certain points. Conversely, having studied a certain area of country, an attempt should be made to form a mental picture of the way in which that particular area will be shown on the map, always correcting the impression if possible on the site. In the same way the slopes of hills and gradients of roads should be estimated and then compared with the map.

Characteristics of Maps.

Identical information and methods of representation must not be expected from British and foreign maps and maps drawn to different scales.

Many features are shown by different symbols on foreign maps, and the symbols vary on British maps according to the scale. All churches, for example, are shown by the same symbol on the ½ in. Ordnance maps, whereas on the 1 in. maps churches with and without towers and spires have different conventional signs. It is always advisable to consult the table of explanations shown at the foot of the map.

Many features are altogether omitted on small scale maps—small woods, bye-roads and footpaths, for instance, will be rarely found. Again, certain lines and features are shown on maps which have no reference to the nature of the country, such as boundaries to parishes and counties (which must not be mistaken for footpaths) and private parks, which are clearly marked by stippling on British Ordnance maps, though they may not be distinguishable from the ground around.

It is essential to know the characteristics of a map before attempting to read it. Maps are so numerous, and with new editions changes are so frequent, that it is only possible to give the scales and salient characteristics of the most important British and Continental Maps.

*British Maps.**—The best known Ordnance maps are those drawn to scales of ½ in., 1 in. and 6 in. to the mile. Contours are shown on all three maps at a V.I. of 100 ft., with an additional contour line 50 ft. above sea level. The ½ in. map, R.F. 1 : 126,720, is published in outline and in colour. The coloured maps can be obtained with the contours supplemented (1) by shading, and (2) by layer tints. The 1 in. map, R.F. 1 : 63,360, is published in outline and in outline with hachures, also in colour (1) with hachures, and (2) with hachures and shading to supplement the contour lines. The 6 in. map, R.F. 1 : 10,560, is in outline. A considerable amount of detail is given, with full indication of its character. In addition to the contours numerous spot levels and bench marks are shown.

* Indexes to all the principal Government surveys, English and foreign, can be seen at Sifton, Praed & Co.'s Map House, 67 St. James's Street, and in peace times specimen sheets can be seen and obtained.

Continental Maps. — Continental maps are drawn to metrical scales, the chief of which are given below. Hill features are shown by contours, hachures, contours and hachures, contours and shading, and in some cases contours and altitude tints.

France.—Scales 1 : 80,000 and 1 : 50,000. The 1 : 80,000 map is in black, and the hill features are shown by hachures only. The 1 : 50,000 map is in colours. The contours, at a V.I. of 10 metres, are supplemented by shading, and every 50-metre contour is accentuated.

Russia.—Scale 1 : 126,000. This map is printed in outline, with the hill features shown by hachures.

Italy.—Scales 1 : 200,000 and 1 : 100,000. The 1 : 200,000 map is in colours. V.I. of contours is 100 metres. The 1 : 100,000 map is contoured at a V.I. of 50 metres. Both maps show hachures or shading.

Germany. — Scales 1 : 250,000, 1 : 200,000, 1 : 100,000 and 1 : 25,000. The 1 : 250,000 map is in colours. V.I. of contours 10 metres. The 1 : 200,000 is also in colours. Contours are shown at a V.I. of 20 metres. The 1 : 100,000 map can be obtained in outline and in colours. The V.I. of contours is 50 metres. Hachures are also shown.

Austria.—Scale 1 : 75,000 ; also 1 : 200,000, a map in colours (and hachured) of Central Europe.

Spain.—Scale 1 : 50,000. This map is in colours. V.I. of contours 20 metres.

Belgium.—Scales 1 : 100,000 and 1 : 40,000. The 1 : 100,000 map is coloured and contoured at a V.I. of 10 metres. The 1 : 40,000 map is similarly coloured and contoured.

Switzerland.—Scales 1 : 50,000 and 1 : 25,000. The 1 : 50,000 map is contoured at a V.I. of 30 metres, with every 300 metres shown by dotted line. The 1 : 25,000 map is contoured at a V.I. of 10 metres.

Special maps are published for the area of operations in war to large scales, such as 1 : 40,000, 1 : 20,000, 1 : 10,000, and in some cases 1 : 5,000.

Setting a Map.

A map is set when it is held or placed on the ground so that the north of the map points to the north, and the various features represented on the map are relatively correctly placed with regard to the objects themselves. When a map is set points in the country can be identified.

There are three ways of setting a map: (1) By compass; (2) by points identifiable on the ground; and (3) by a straight length of road or railway.

1. *Setting by Compass.*—Open the compass out flat and place it on the line of magnetic north, produced, if necessary, so that the line of direction of the compass, shown by the notch on the brass ring and the notch on the flange of the cover, is aligned with it. Turn the map slowly round without shaking the compass until the magnetic needle coincides with the line of magnetic north. The map is then set.

2. *Setting by Points Identifiable on the Ground.*—Two objects on the map are selected, one of which must be the position in which the map is being used and the other must be visible, say a church spire. Place the long edge of the service protractor on the line joining these two points and move the map round until the protractor is aligned on to the church. The map is set. If the point at which one is standing is not identifiable, choose two objects, one behind the other. Join the representations of these two objects on the map by a line, and when the line thus drawn points to the two objects on the ground, which are in alignment, the map is set.

3. *Setting by a Straight Length of Road.*—Hold the map in such a position that the road on the map points the same way as, or is parallel to, the road itself. Most churches are oriented and maps can accordingly be set by them.

A map can always be approximately set, as it should be in map sketching, without using the compass or drawing rays when several recognised objects can be seen.

Resection.

It may be necessary sometimes to find the exact position taken up on the ground if not standing near to any easily recognised objects. This may be done either with the compass—in which case the map need not be set—or by drawing rays. Resection by compass is explained on page 100 and on Plate XXXI.

To "resect" a position without a compass the map must be first set. Two distinctive objects in the distance which can be identified on the map are noted. Placing a straight-edge on the map and pivoting it on the representation of the two objects in turn, rays are drawn when it is aligned with the objects in the country, and the intersection of the rays (produced backwards) will give the position. The angle made by the intersection should be neither obtuse nor acute.

If standing on a road obviously one's position can be resected by compass or straight-edge from one object only. The map is set, and when the straight-edge is placed on the representation of the object and aligned on the object in the country itself, a line drawn along it will cut the road at the point at which one is standing.

Maps and the Ground.

As soon as a map is opened out the scale to which it has been drawn must be ascertained. Only when this is known can one realise the relation of the map to the country, and the length of actual ground represented—e.g. by 1 in. on the map—be grasped.

Maps are drawn with the top to the north, but the north point must be looked for, as by it the map will be set. In the right-hand margin of the map will be seen a little diagram showing the true north, and also the line of magnetic north (Plate III., 19). The amount of the magnetic variation for the part of the country shown on the map is figured. If the line of magnetic north is not shown it must be put on with the protractor if the map is to be set by compass.

When the map is set one should be able to identify all the features of the country, both natural and artificial, and trace the various undulations of the ground.

To identify any feature, when doubts exist, it is only necessary to place the edge of the protractor on the map immediately over one's own position and the representation of the object it is desired to identify. The protractor will then point in the right direction. If it is desired to identify some distant feature of the country on the map the protractor is pivoted on the representation of one's position and aligned with that object. A line is drawn along the protractor, and somewhere along this line the desired feature will be found.

Studying the formation of ground is more difficult than picking up such objects as buildings and woods. If the V.I. of the contours is a large one, carefully note all spot levels. They give the height of the summits of hills and also of points intermediate between the contour lines, and are accordingly a great aid in realising the actual nature of the slopes. Hachures also define the various under-features, and should be well studied.

It is a wise plan, if the streams are not well marked, to run a blue line along them, however small they may be. The rivers and streams, when their positions have been discovered on the ground, form a framework round about which the various formations of the ground can be identified.

To identify the various features seen and to grasp ranges, it is, as has already been pointed out, absolutely essential to realise the relation of the scale of the map to the ground. Distances can be measured on the map in several ways, by dividers, the service protractor, and a paper scale ; and it is worth noting that when accuracy to within 100 yards is not necessary, time need not be spent in referring to scales. The following will give approximate results : The width of the thumb placed on the map = 1 in. Four fingers = 3 in., and the hand 4 in. Both the diameter of ½*d.* and three lines on foolscap paper equal exactly 1 in.

Allowance for the undulation of the ground will soon come with practice, but it is not easy to realise the "perspective" of the country. If two villages are both two miles away and only half a mile apart, owing to the foreshortening they will appear to be further apart from one another than they are from the observer.

For the same reason bends in roads and rivers appear much more exaggerated on the ground than they really are and are shown on the map.

In estimating distances the following should be remembered :—

Distances are usually under-estimated—

1. When made in bright sunlight or a clear atmosphere.
2. When the sun is behind the man estimating.
3. When made over uniform surfaces and over water.
4. When the object is set off by a bright background.
5. When made over undulating ground, and depressions cannot be seen.

Distances are usually over-estimated—

1. When made in a flickering light.
2. When made against a dark background.
3. When made against the sun.
4. When the sky is overcast, or in the dusk.
5. In foggy weather.
6. In woods.

Estimates made from a height downwards are usually too short, and those made from low ground up, too great.

The method of getting the exact position, and also the distance, of objects with the prismatic compass is explained in the description of the use of that instrument.

Maps may have to be read by night under such conditions that no light of any kind must be shown. For this a Radium Map Reader is extremely useful. This little instrument consists of a lens, magnetic needle and scale, and is illuminated by radium. The Reader is placed on the map with the scale line in alignment with the marginal line—or a line parallel to it—and the map and Reader are turned round until the N end of needle points on the small arc showing degrees to the magnetic variation for the locality. The map is then set and the Reader can be moved to any other part of the sheet. Not only is the map lit up by the radium and magnified, but it is also possible with the aid of the magnetic needle and graduated arc to estimate bearings.

Visualising Country.

Maps of country which has not been seen, and of the general character of which one has no indication, are best read if, before studying any part in detail, the following be the method of procedure :—

(1) Look for the scale and thoroughly grasp the actual length of ground which is shown by 1 in.

(2) Note the V.I. of contours and the general method of showing hill features.

(3) Measure or gauge the size of the sheet, and look upon it as representing an area of country of x miles by y miles. Picture what this means by comparison with any area of country which you know well and of the same size. Estimate the time it would take to march or ride from the bottom of the sheet to the top.

(4) Look for the big rivers and their tributaries—the "system of drainage"—and note the highest hills. Form a general idea of the distribution of the low-lying valleys and the high ground—"Think in relief."

(5) Look for the big towns and villages, the chief means of communication, and any prominent features such as forests, large commons, marshes, etc.

When the map can be looked upon, not as a diagram but as a view of an expanse of country as seen from an aeroplane, picturing its general nature and characteristics, one may safely examine in detail the whole or any part required.

Reference to Positions on Maps.

In referring to positions on maps the number, name and scale of the map used must first be given.

a. On the British Ordnance and other unsquared maps the position of a point is described with reference to the points and bearings of the compass and the lettering of the map :—

(1) "Point, 320 yds. S. of the junction of OAK WOOD with the LICHFIELD-COVENTRY Road."

(2) "Copse, 480 yds., bearing 47° True from NETTLE BANK FARM."

(3) "Hill, 850 yds. N. of M in FRAMPTON."

Names of places must always be given in block letters, and letters referred to must be underlined.

b. Squared Maps (Plate XIX.). In the case of squared maps reference to points is simplified. Maps are divided by strong lines, red or black, into a few rectangles distinguished by large block letters. These are divided by thinner lines into small squares, each of which is numbered and has sides of a definite length according to the map—e.g. 1000 yards. Each numbered square is again divided into four, each known by a letter (italics), *a*, *b*, *c* or *d*, and having sides representing 500 yards in length. Only a few are actually lettered to avoid confusion. A point can be identified as being A. 14. *b*. S.E. or any other point of the compass according to its position in the square *b*. If the reference is A. 14. *b*. it is understood to mean the centre of the square.

On Plate XIX. the position of the Hall would be T. 9. *a*. and the cutting T. 8. *a*. N.W.

For greater accuracy in describing a position each small square can be divided into 100. The sides of the 500 yards squares on most maps are divided into 10 by small ticks, and lines are simply drawn across (Plate XIX.). The lines are always numbered from the bottom left-hand or S.W. corner, which is called zero. Distances are measured from W. to E. along the bottom line first, and then from S. to N., to give the exact position of the point. The N. and S. line is never taken first. Example: A. 14. *b*. 27., meaning that the point is 2 squares from the left side of the square *b* and 7 squares up.

On Plate XIX. the position of the farm would be T. 8. *d*. 01.

If still greater accuracy is required one of the smaller squares just drawn can be imagined to be again subdivided into 100 squares, and the position of the point is described to two places of decimals, always using, to avoid confusion, four figures, never three—thus: A. 14. *b*. 20·78, meaning that the point is exactly two squares from the left side of square *b* and $\frac{78}{100}$ths beyond the square 7.

SQUARED MAPS

SHEETS ARE DIVIDED INTO LARGE RECTANGLES.
EACH RECTANGLE IS DIVIDED INTO NUMBERED—
SQUARES OF 1000 YARDS SIDE.
EACH NUMBERED SQUARE IS DIVIDED INTO FOUR—
LETTERED SQUARES OF 500 YARDS SIDE.

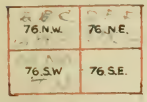


FIG. 1. INDEX TO SHEETS.

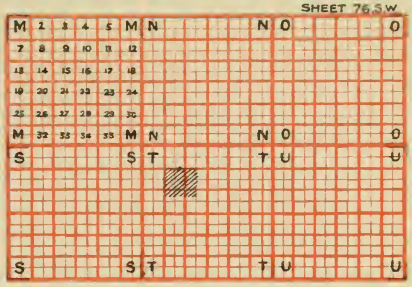


FIG. 2. SQUARING OF SHEET.- SCALE 1:20,000.

FIG. 3. DETAIL OF SHADED PORTION OF FIG. 2.

POSITION OF THE HALL IS T. 9. a
POSITION OF THE CUTTING IS T. 8. a. N.W
POSITION OF THE WINDMILL IS T. 8. d. 86. *or, more accurately* – T. 8. d 87.67.
POSITION OF THE CHURCH IS T. 8. d. 38. *or, more accurately* – T. 8. d. 32 88
POSITION OF THE INN IS T. 8. d. 42. *or, more accurately* T. 8. d. 46.27.

On Plate XIX. the position of the school would be T. 8. *d*. 97·97.

The same system of squaring is used on maps drawn to the scale of 1 : 40,000, 1 : 20,000, 1 : 10,000 and 1 : 5,000, the squares obviously becoming larger as the scale of the map increases. It is, therefore, possible to refer to a point on the 1 : 10,000 map, and locate it on the 1 : 40,000. With the aid of these squares, distances and ranges can be rapidly gauged.

Pieces of celluloid can be obtained* which have squares ruled on to show the 500 yds. square divided into fifties for the different scale maps, and their use saves much time and also covering the map with pencil lines.

Other methods of squaring maps have been used, but the principle is the same, and an explanation is always given at the foot of the sheet.

* Price 2/- net. Sifton, Praed & Co., Ltd.

2. PANORAMA SKETCHING.

1. **Landscape Sketches** PAGE

Value of Military Sketching 72
Panorama Sketches 74
Target Indication 76

2. **The Technique of Sketching**

Constructing the Framework 78
Filling in the Details 81
Completing the Sketch 84

1. LANDSCAPE SKETCHES.

Value of Military Sketching.

The object of a military sketch is the collection and transmission of information in a simple and legible form. Landscape sketching for military purposes does not necessarily presuppose an accomplished draughtsman ; almost every officer and most N.C.Os. with practice can gain sufficient facility with pen or pencil to enable them to make a drawing which will convey information of military value.

The uses to which landscape sketching can be put are as follows :—

1. In unmapped country the only method of recording graphically some necessary and important information may be the panorama sketch. Ground occupied by the enemy, foreign territory, or ground that for any reason cannot be traversed can be shown by a panorama sketch which—made from some point of vantage—may give all the information necessary for the consideration of some strategical or tactical scheme. Such a sketch is, in effect, an "elevation" of the country, taking the place of the "plan" or map.

2. A panorama sketch may be a valuable adjunct to a map. A sketch showing the country over which it is intended to make an advance, a position held by the enemy, or a proposed site of battle will give much useful supplementary information.

There are many things which the official maps alone cannot show. The nature of fences, whether they are likely to give cover or not, the wooded nature of the country, crops, minor undulations of the ground or prominent objects—these, and many other features, all of military importance, can best be indicated by a sketch. On Plate VIII. will be found a sketch map on which is marked the area of country actually shown on the panorama (Plate XXVIII.). The two sketches should be compared.

Time is of importance. A large area of country can be shown by a panorama sketch in one hour; to map the same area would be a matter of days.

3. In the manual of Field Artillery Training the use of the panorama sketch to the battery commander is described as follows:— "A panorama sketch of the enemy's position should, if possible, be made, and will save much writing. For firing at moving objects from under cover, for switches, and in night firing a sketch of this nature is invaluable." Plate XXI. shows a panorama sketch made for artillery purposes, omitting, however, the angles of sight. A panorama range card is similarly useful to machine gun and trench mortar batteries.

4. Panorama sketches and range cards for rifle fire can be combined. A panorama range card for a defensive position is shown on Plate XXVIII. By sending back such sketches to the outpost commander the picquet commander gives valuable information as to the nature of the ground over which the enemy will have to advance or the position he may hold.

5. Sketches effectively indicate the position of targets. In trench warfare such detail sketches as shown in Plate XXVI. are of use as indicating the position of snipers, trench mortars, machine guns, etc. They are useful for our own snipers and batteries and to hand over to a new unit when the line is relieved.

Landscape sketching trains a man to become observant. The painter who, in his sketching, is always looking for the beautiful in the landscape will naturally, when not at work, see more readily than the layman the artistic possibilities of the country side. A man who sketches trying to discern and show points of military importance will similarly grasp more readily in the course of his daily work many little points of military value—he develops an "eye for country." Intelligent landscape sketching is also a great aid to efficiency in map reading.

The ability to sketch is a useful accomplishment. Sketches of landmarks, bridges, fortifications or buildings which it is desired to put into a state of defence are useful additions to reports and sketch

maps (Plate XVI.) and convey more information than the most elaborate and carefully written descriptions.

Panorama Sketches.

Panorama sketches are made, as a rule, in Army Book 153, the paper of which is smooth, and therefore suitable for both ink and pencil work. The faint blue squares will also be found a guide in both making and finishing up the drawing.

The pencil used may be an H.B., F. or H., but nothing softer than an H.B. Lines made with a soft pencil rub easily, and varying pressure with the pencils recommended will always give the necessary different strength of line for objects in the distance and foreground. The pencil must be kept sharply pointed. Chalks—red, blue and brown—are required.

Pencil and chalk drawings are liable to get rubbed and smeared with use. This may be to a certain extent obviated if the surface of the paper is washed over with milk or water.

Drawings which are likely to be handled a lot would be more permanent if made in waterproof Indian ink. Ink, also, as a medium has its limitations, and the sketcher will find it easier to simplify and conventionalise with the pen than with the pencil (Plate XXVI.). The value of a panorama drawing will greatly increase according to the number of copies available. If the drawing be made with the necessary special ink very simple and small apparatus (such as the Hectograph) would be required to reproduce in the field sufficient copies for all purposes.

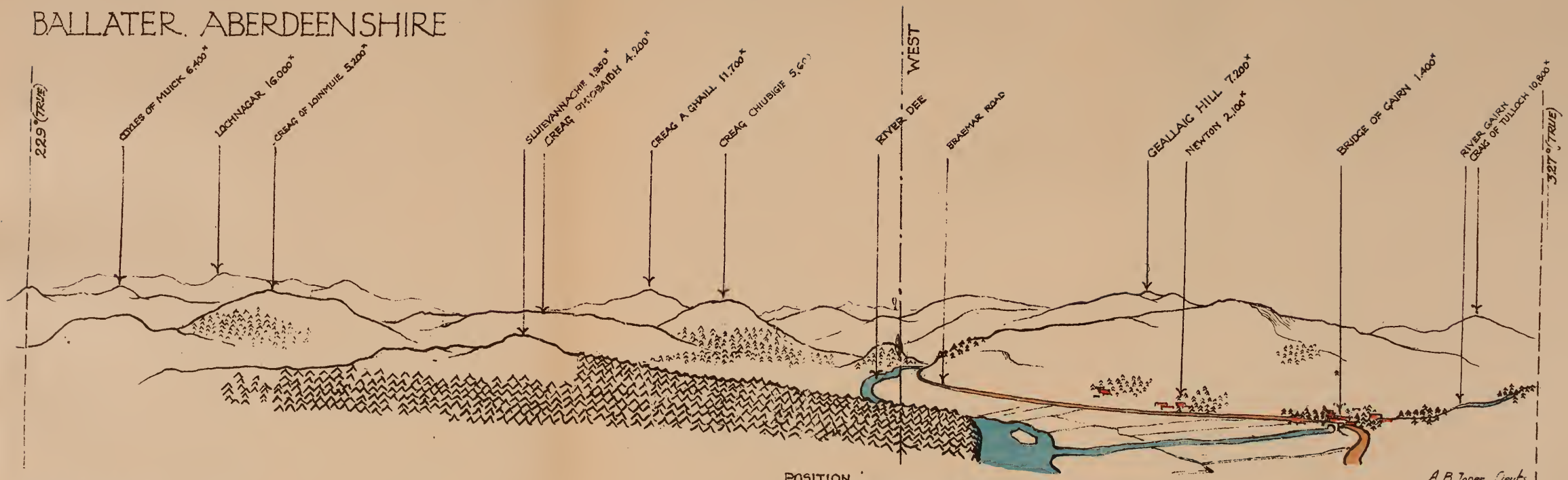
The selection of a suitable position from which to make the drawing is important. Unless the sketch is to be made from a position already fixed (*i.e.* an outpost line) a spot commanding good views with little obstruction in the foreground should be chosen. If in proximity to the enemy concealment must be considered. A suitable background is necessary and as little movement as possible must be made.

The next step is to decide upon the extent of country to be shown. The area of country that can be conveniently sketched and

PANORAMA SKETCH

PLATE XX

BALLATER. ABERDEENSHIRE



Ranges from Bartholomew's ½" Map

POSITION
View looking W from Craigendarroch Hill.
Height 900.0.

A. B. Jones. Lieut:
½ 2nd Regiment
Dec. 31st 1915. 1.30 P.M
State of Weather – Slightly Misty.

drawn to a reasonable size on one page of Army Book 153—$6\frac{1}{2}$ in. × $4\frac{3}{4}$ in.—will be found to be that which is included in an angle of 30° from the spectator.

A simple way of ascertaining approximately how much of the ground is included in this angle is to place the thumbs together (not the tips only) and stretch the fingers out to their full extent, then with the arms extended in front the two extreme finger-tips will show the limits of the views, *i.e.* subtend an angle of 30°. At arm's length also the outstretched fingers and thumb of one hand subtend an angle of 18°, and the knuckles of the clenched fist 8°.

If it is desired to show a greater extent of country than is included in the angle of 30°, it is better if the sketches be made on separate pieces of paper and fastened together afterwards (Plate XX.). In the case of telescopic sketches—sketches made by the aid of a telescope or powerful field-glasses of country some distance away and omitting the intervening ground (Plate XXII.)—the angle of view may be less than 10°. That the angle be 30° is not a hard-and-fast rule. To show any given extent of ground the further away the sketcher is the less the angle necessary, the nearer he is the greater.

With an angle of 30° the following shows the extent of frontage at given distances :—

Distance 100 yds.	Extent of Frontage 50 yds.
,, 500 yds.	,, 275 yds.
,, 1000 yds.	,, 550 yds.
,, 2500 yds.	,, 1300 yds.
,, 5000 yds.	,, 2600 yds.
,, 5 miles	,, 4500 yds.

Before attempting the panorama it is most essential that the sketcher should fully realise the object for which the drawing is being made. That it is to give information is obvious, but it is necessary to give the right kind of information for the object in view, and anything which is not relevant must be omitted. A photograph, though it may take time to reproduce, will give an accurate representation of the country, but it is only the sketch which can emphasise the points of military value.

The ground must be thoroughly examined through field-glasses, and whenever possible with the aid of the map. No attempt should be made to put pencil to paper until the ground has been most carefully analysed, bit by bit; then, and only then, can an intelligent military drawing be expected as a result.

What to show and what to omit will depend upon the purpose of the sketch. Except in the case of sketches made from trenches the immediate foreground is of no value, since obviously it can only be of very short extent and may change 50 yards to the right or left of the sketcher's position. It should, therefore, be omitted, as should any trees or buildings which obstruct the view. With the absence of foreground the front on which the sketch will present a similar appearance will be extended.

Conspicuous landmarks and all features of military importance, roads, bridges, rivers, marshes, woods, hedges, folds in the ground giving cover, the nature of the ground itself, and in particular information not conveyed on the maps, must be clearly shown.

Target Indication.

A type of sketch, which cannot properly be called a panorama, since it embraces in most cases so small an angle of view, is that which is made in trench warfare for the purpose of recording the position of targets, such as sniper posts, observation posts, machine guns, batteries, etc.

The aim in making such sketches is to show at a glance any desired position, perhaps hardly noticeable to the naked eye, by linking it up with more or less prominent and easily identified objects of the landscape. The salient characteristics of these objects must be accentuated, and by shading, colour, or pronounced lines the eye should be carried at once to the target.

Sketches for the identification of targets can be made through a periscope, with which also field-glasses can be used. The periscope is securely fixed in such a position as to show the desired area, and it will be found that sketching, when the view is limited by a small aperture, is much simplified. If the area to be shown is extensive,

PANORAMA SKETCH FOR ARTILLERY USE.

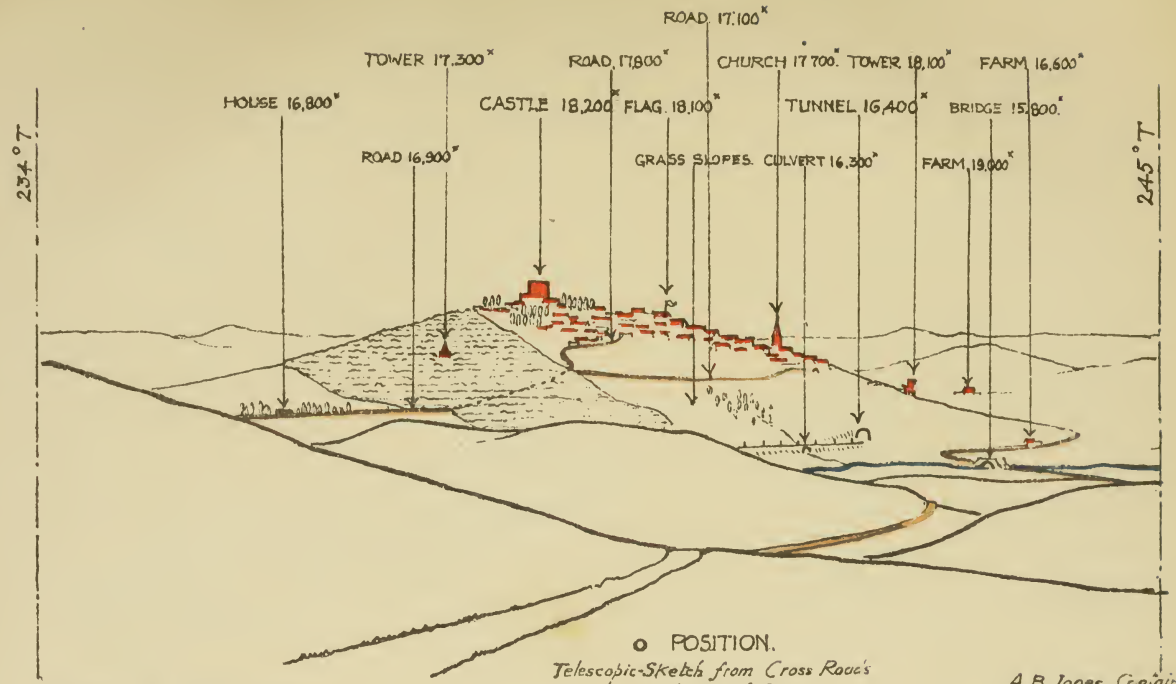
PLATE XXI

15° — Brow of Hill 1,400 yds
10° — Enfield 7,900 yds
5° — Factory 4,140 yds
0° — Factory 4,400 yds
5° — Church 5,380 yds
10° — Reservoir-E.Side 2,760 yds
Railway Station 8,800 yds
Glass Building 2,190 yds
Road 1,100 yds
Church 8,550 yds
Reservoir-W.Side 3,610 yds
15° — Railway 4,030 yds
Pumping Station 2,660 yds
Road 1,700 yds
Railway 5,460 yds
10° — Brow of Hill 1,100 yds
15° — Small Arms Factory 3,460 yds

POSITION
View looking W. from a point 400 yds N. of ⊠ in Wallsgrove House
High Beech. Essex. Reference Map 108

TELESCOPIC SKETCH

PLATE XXII



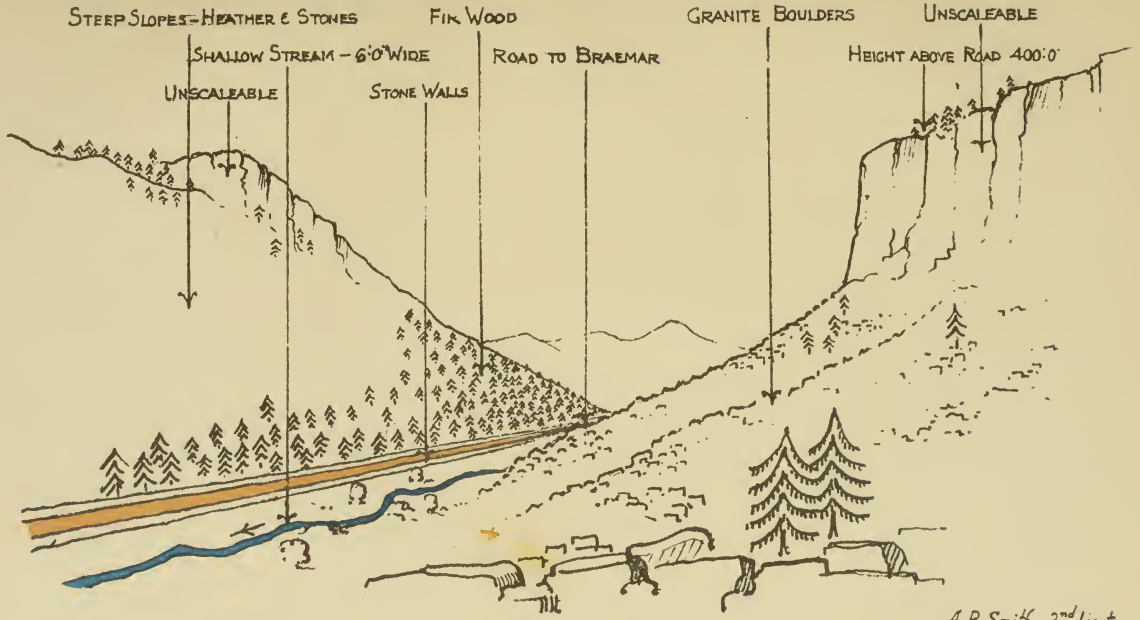
Ranges by Range-Finder

A.B. Jones Captain
59th Regiment
12.30 Noon 5.6.1915
Weather – Very Clear.

RECONNAISSANCE SKETCH

PLATE XXIII

PASS OF BALLATER.



VIEW LOOKING W. FROM E. ENTRANCE TO PASS

A.B. Smith. 2nd Lieut
94th Regiment.
Dec 31st 1915 - 11.0 A.M.
State of Weather - Misty

the periscope can be moved round and two or three drawings made, which can be pieced together afterwards if features common to adjoining sheets are shown on their extreme edges.

In the selection of easily recognisable features around the target, care must be taken to choose those which as nearly as possible are in the same plane as the target itself, since the latter may not always be viewed from the spot from which the sketch was made, and would, therefore, appear in a different position in relation to objects much in advance or to the rear of it if seen from any other point.

For the actual drawing, the principles laid down for panorama sketching apply equally to the sketches now described. The drawing is completed as shown in Plate XXVI. The position from which it has been made must be given by a map reference, and the compass bearing on to the target itself is shown. In addition, a map reference should be given to some identifiable features near to the actual object.

2. THE TECHNIQUE OF SKETCHING.

Constructing the Framework.

On the paper mark the limit in width of the sketch. This should be 6 in., or the length of the service protractor, and will leave with Army Book 153 a margin of about $\frac{1}{4}$ in. at each edge. Next hold a pencil upright and at arm's length, with the tip coinciding with the sky-line, and slide the thumb up or down until the top of it appears to just cover the point in the foreground which it has been decided shall be the limit in depth to be shown on the sketch. Holding the pencil horizontally, find how many times this, the depth, will go into the length decided upon, and mark off on the paper the proper proportion of the sketch accordingly. This should be carefully done, as one of the chief difficulties in panorama sketching is obtaining proper proportions. The usual tendency is to make the sketch too deep, nearly a square, when the proportion of depth to length will more probably be 1 to 6.

The general shape of the sketch, which has now been ascertained, must be indicated on the lower half of the paper in order to leave room above for the heading and descriptions.

Within this oblong all the features of the selected area of country are to be drawn. Imagine a small window in a room similar in size to the oblong, and that one is standing in such a position that through the glass the exact area of country to be sketched can be seen. Standing in the one position, with a long paint-brush it would be possible to draw on the glass all the lines of the country just as they were there seen, and the result would be a panorama sketch.

In the first stages of a panorama drawing, imagine a sheet of glass in front of your position, and that all the features of the country, whether five yards or five miles away, are on that glass, or,

in other words, in one vertical plane. Then fix, by any of the following methods, a number of conspicuous features in the landscape in their correct relative positions on your paper (see features in black, Plate XXIV.), and the result will be a diagram or framework round which the remaining details of the country can be drawn with little fear of going wrong.

The framework of fixed points can be obtained in several different ways :—

1. *Compass Bearings.*—Bearings are taken with a prismatic compass on to objects which are on the right and left limits of the area to be sketched. These will be represented by the lines drawn down the two edges of the paper, and the space between is divided up to show, say, every 5 degrees. Compass bearings are now taken on other objects, and their position recorded on paper by means of the dividing lines thus drawn. If desired, the position of various features as regards their height on the sketch can be obtained by means of a clinometer. This is an accurate but slow method.

2. *Graticules.*—As in the previous method, compass bearings are taken on to the objects forming the right and left limits of the area to be sketched, and the space between the lines representing these limits on the paper is divided up to show degrees.

With field-glasses having lines marked vertically across them, each representing an angle of one degree from the eye—graticules—the number of degrees any object is to the right or left of the limits of the sketch can readily be found. Important detail is at the same time rendered visible with the glasses.

3. *Squared Celluloid.*—A piece of celluloid with 1 in. squares drawn on to correspond with every fourth square of Army Book 153 is held or fixed in such a position in front of the sketcher that he sees through it the exact extent of country he wishes to show. Important features (and much of the detail) are then drawn on the paper, square by square, as seen through the squares of the celluloid.

Celluloid may be marked in other ways than by 1 in. squares. It may be marked to show every two or five degrees at a given distance from the eye. The method of use is similar to the above,

but lines must be drawn on the paper to correspond with the lines of the celluloid.

4. *Service Protractor.*—The service protractor is so held in front of the sketcher that the two short edges appear to coincide with imaginary vertical lines running through the objects chosen as the limits of the view. The position of other objects is noted with regard to the various marks shown on the long edge of the protractor, which is then placed on the sketch, the length of which is 6 in., equal to the protractor, and the position of the objects can be ticked off.

If there are many points to be fixed, it is a good plan, when the protractor is correctly held, to attach a piece of string to it and make a knot in the other end so that it can be held by the teeth. The protractor then will be always held the same distance away, and it can be turned sideways to fix the different points in the height of the sketch.

5. *Book.*—The sketch-book is held upright in the left hand so that the lines on it which denote the limit of the view coincide with the actual limits. With the right hand lines are drawn down the book to indicate the points where various features appear to cut the top edge of the paper, and on them the features are drawn in their correct positions.

6. *Thumb and Pencil.*—(Plate XXIV.) The method of finding the proportion of the depth to the length of the drawing has already been described, using the pencil and thumb. In a similar way by moving the thumb along the pencil and by trial the position of the centre line and lines dividing the length into quarters, and also a line one-half the depth of the picture, can be fixed. Note objects in the country where these lines occur and mark them on the paper.

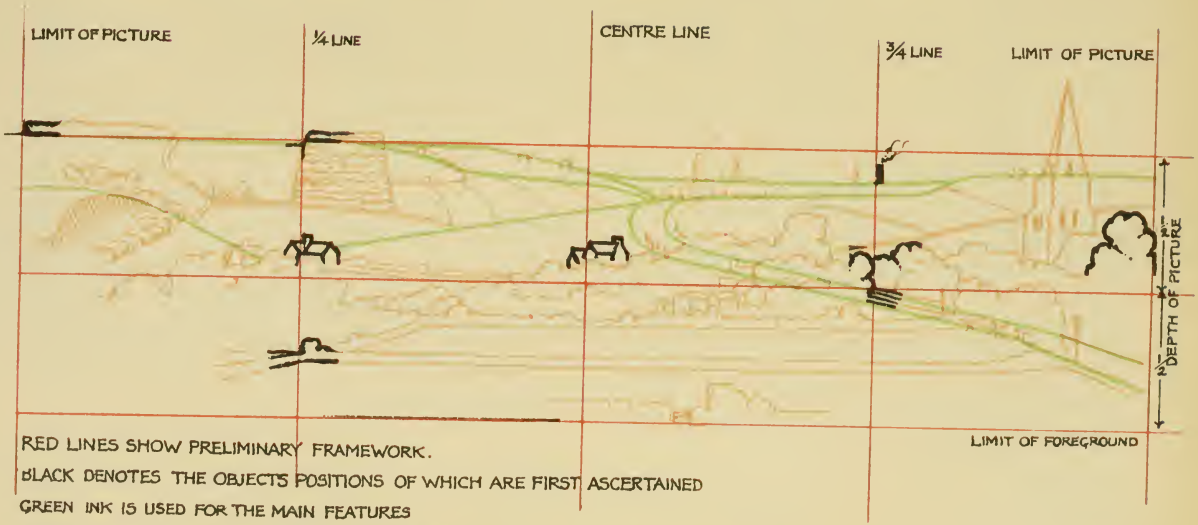
Whichever method be adopted, and any of the above may be combined, practice will lead to speed, and as time goes on it will be necessary to fix fewer and fewer points.

When the "framework" has been constructed by fixing various prominent objects, these are linked together by drawing in the main features of the country, roads, rivers, hills, and folds in the ground

PANORAMA SKETCH METHOD OF SETTING OUT PLATE XXV

LONGSDON. STAFFORDSHIRE.

VIEW LOOKING S.W. FROM THE WATERWORKS INN.



RED LINES SHOW PRELIMINARY FRAMEWORK.

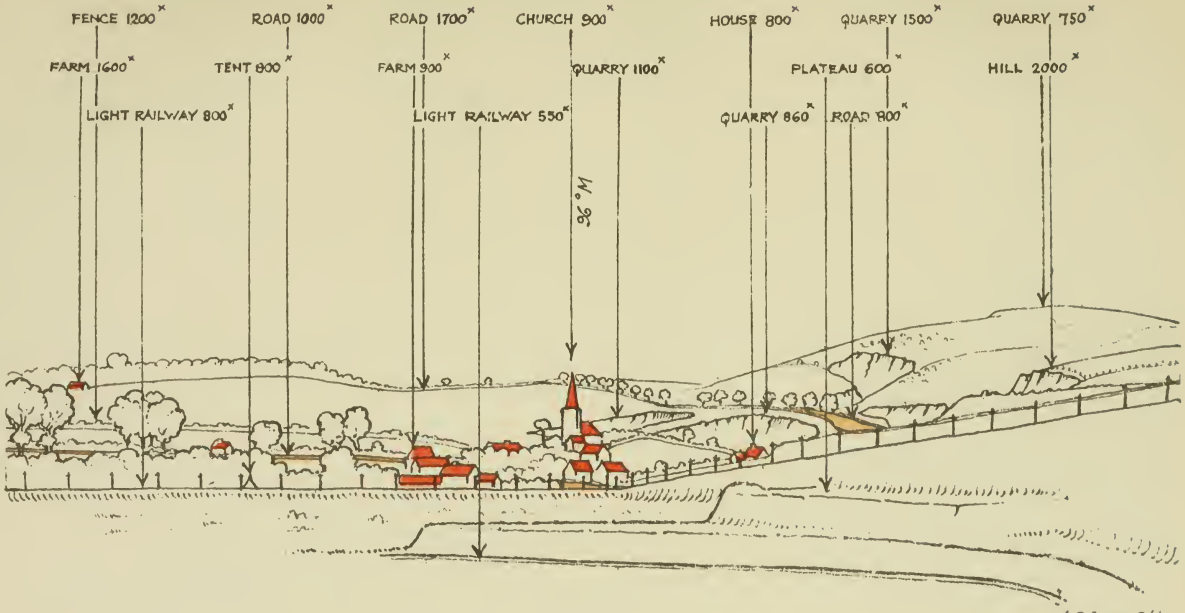
BLACK DENOTES THE OBJECTS POSITIONS OF WHICH ARE FIRST ASCERTAINED

GREEN INK IS USED FOR THE MAIN FEATURES

BROWN INK IS USED TO COMPLETE THE NECESSARY DETAIL

NÈSLES: PAS-DE-CALAIS.

PLATE XXV.



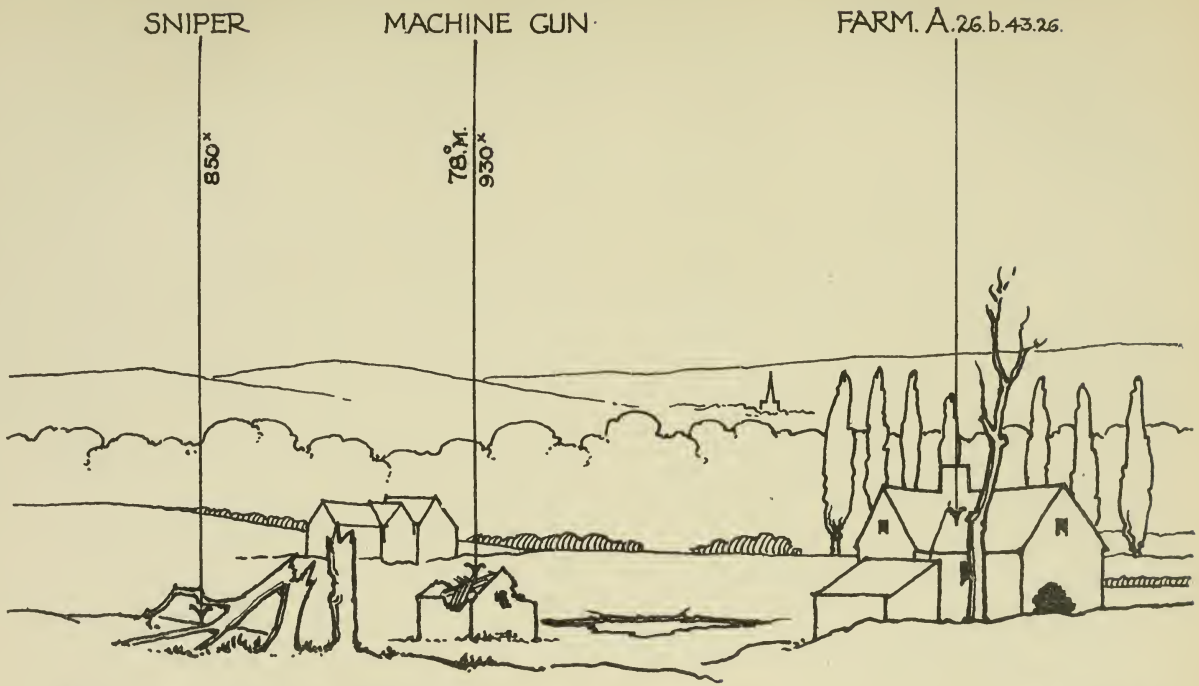
Ranges estimated

o POSITION
View looking E from point on the Road
BOULOGNE - NÈSLES 150 yds S. of Railway Bridge

A.B. Jones 2 Lt.
3/4 Blanks Sires.
4. P.M. 17.8.16
State of Weather - Raining

TARGET INDICATION

PLATE XXVI.



SKETCH FROM A.39.c.73.14.

9·30.A.M. 5.6.16.

(green lines, Plate XXIV.) These are shown by single light lines—just the bare skeleton—and any mistakes that may have been made in proportion are now corrected.

The usual tendency to exaggerate the slopes of hills must be checked, and until a sense of proportion is developed the following method should be adopted in drawing both the hills and roads, fences and other long lines of the landscape :—

Hold the book upright with the protector, kept in place by the thumb, showing above the top edge. Then, keeping the edge of the book quite horizontal, the free end of the protector is moved up and down until the top edge is aligned with the slope it is desired to draw. Along the bottom edge a pencil line is now drawn which will act as a guide in drawing in the required features.

The general proportions correct, such detail as may be necessary for the object of the sketch is now shown.

Filling in the Details.

In completing the sketch by the addition of the necessary detail there are five important points to be borne in mind.

1. The sky-line and all features in the distance must be drawn lightly, and with a simple line, and each nearer "vertical plane" with its various features must be drawn more distinctly than the one more remote, until the foreground is reached and shown by strong black lines.

2. Draw in outline. Attempt no light and shade or the indication of small detail. Let every feature be shown by its outline or mass.

3. All features, both natural and artificial, must be simplified and conventionalised. This does not mean using the symbols for map sketching, but rather showing objects by shapes which take but little time to draw and at the same time convey the desired impression.

4. All the features should be relatively correct in size. There is always a tendency to exaggerate both the slopes of the ground

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and the size of roads, trees, houses, etc., which has the effect of making these objects appear to be nearer than they really are.

5. The perspective must be correct. Remember that hedges, roads, railways, etc., will appear to get smaller as they recede from the sketcher.

Study the landscape through glasses and after careful analysis, bit by bit, begin by drawing in lightly (but not so lightly that the lines will be easily rubbed out) the sky-line and distant folds in the ground. Features on these planes will be small and very simple. Continue by drawing the nearer planes with darker lines, at the same time paying more attention to the form and detail of the objects contained on them, until in the foreground the actual shapes of trees, buildings, etc., may be suggested. Plate XXVII. will show how to simplify and draw the various features of which the sketch will be composed. The following examples are given :—

Roads.—Roads are shown by two continuous lines, the width diminishing as they recede. They are coloured brown. Roads passing over hills or spurs should be carefully drawn to express the shape of the ground over which they run.

Ponds.—Ponds and lakes are shown by outline and coloured blue.

Rivers.—The lines for rivers should have a special quality expressing the broken water's edge. They are coloured blue.

Woods.—The amount of detail varies according to the distance. Woods far away are shown by single outline, and for those near to the shape of the tops of trees is indicated. Fir woods are shown by a series of angular lines.

Trees.—Trees are shown in outline only. Trees in the foreground are indicated by an outline expressive of the general character of the tree according to its type. Dead trees and trees destroyed by shell fire are shown with a trunk and a few ticks or broken lines for the branches.

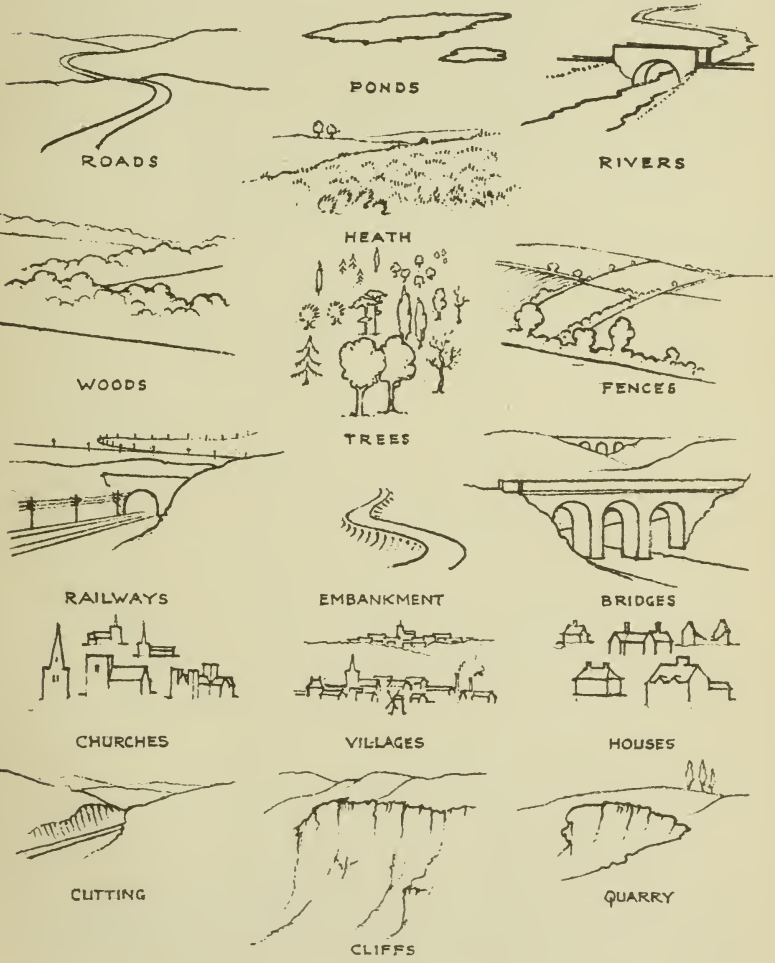
Heath.—A heath is shown by a series of short ticks. The shape of gorse bushes may be shown as indicated.

Fences.—Fences are shown by single or double lines. By carefully drawn fences the character of minor folds in the ground can be

PLATE XXVII

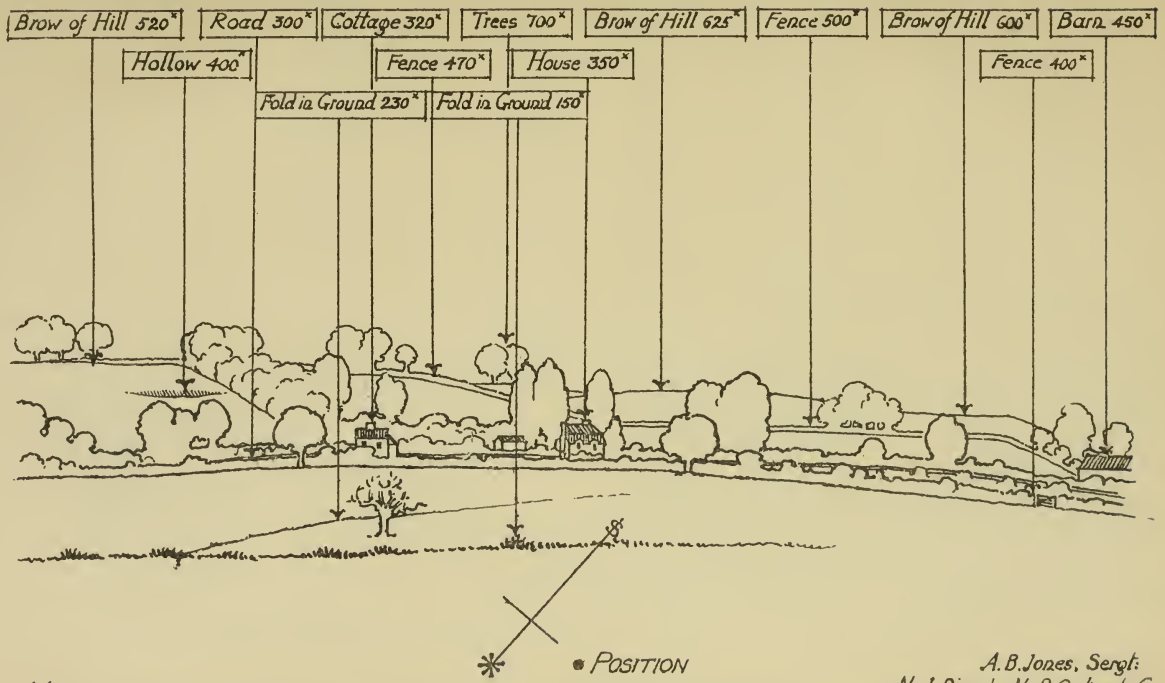
PANORAMA SKETCHING

NATURAL AND ARTIFICIAL FEATURES CONVENTIONALISED



PANORAMA SKETCH WITH RANGES FOR RIFLE FIRE

PLATE XXVIII



VIEW FROM CENTRE OF E. SIDE OF BARN HILL WOOD

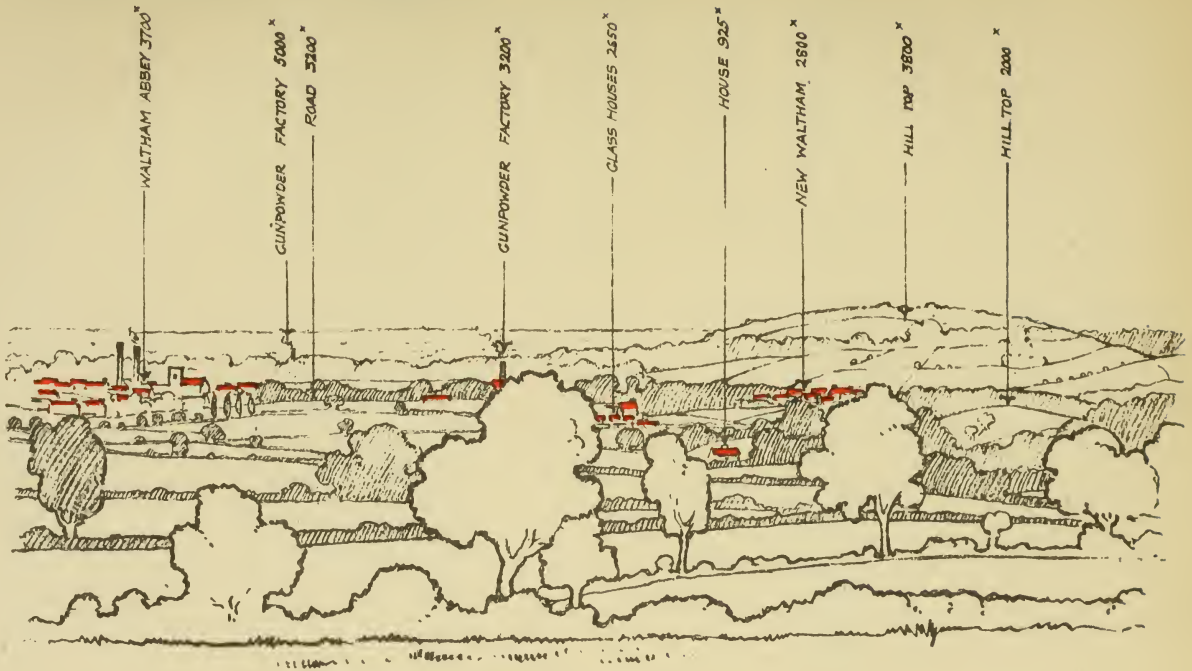
Note: See also Plate VIII

A. B. Jones, Sergt:
No 1. Piquet No 2 Outpost Co.
Barn Hill Wood
June 25th 1915

PANORAMA SKETCH

PLATE XXIX

HIGH BEECH. ESSEX.



Ranges from 1" Ordnance Map.

VIEW LOOKING N.N.W. FROM MANOR FARM
Height 225·0

indicated. The furrows of ploughed fields may be shown, and they similarly indicate the undulations of the ground.

Railways.—Railways in the distance are shown by single line only. Little ticks for telegraph poles usually mark their position.

Embankments.—Short curved lines show both the shape and extent—in depth and length—of an embankment.

Bridges.—Bridges are shown in outline—piers, arches and parapet only being indicated.

Churches.—Shown in outline, sufficient to indicate shape and mass. No details necessary. Red is used for the roofs.

Villages.—Villages both in the distance and near to are shown by a few rectangular shapes as a contrast to the undulating lines of the country round. Touches of red are used to show the roofs of buildings.

Houses.—Houses are shown in single outline, with any characteristic features clearly marked. Red is used for the roofs.

Cuttings.—The outline of the cutting is drawn, and short lines or ticks, slightly darker at the top than the bottom, are drawn down the slope.

Cliffs.—The fissures in the rocks are suggested by short broken lines. Loose stones or shale can be shown by a few lines and dots.

Quarries.—The edge or outline of the quarry is shown by a dark line with a few vertical lines to show the cut rock and fissures.

Do not show any shade or shadows. Light lines may be drawn across woods and belts of trees—curved to indicate the surface of the object—when it is necessary to emphasise targets or to make a distinction between different planes which might otherwise become confused. (Plate XXIX.).

In general, simplify as far as possible, showing features in outline and eliminating entirely all unimportant little details. Emphasise all targets and points likely to be of military importance, always remembering the object for which the sketch is being made. Never attempt to make a picture.

Plates XX. to XXIX. give examples of panorama sketches and should be studied. A little practice in copying suitable pen and

pencil sketches will enable the draughtsman to gain confidence before making his first panorama out of doors.

Completing the Sketch.

Landscape sketches should be finished with such clearness and precision that they can be studied under the most adverse circumstances. Artistic effect is never desirable—a clear expression of facts having some military value should be the aim of every draughtsman in the field.

Colour helps to make the sketch readable. Red chalk is used for buildings, blue for water; and brown for the roads will help to make the distant windings and turnings more easily followed.

The written information is of almost equal value with the sketch. It should be in block letters or, for the smaller notes, italics.

Headings.—Every panorama must have its heading stating the part of the country sketched and the general purpose of the drawing.

Objects and Ranges.—Objects must be named and any useful information concerning them—*e.g.* nature of crops, density of woods, materials of bridges, etc.—should be stated. The ranges must be given and a note added in the bottom left-hand corner of the sketch stating the method adopted to obtain the distances, whether by range-finder, estimation, or from the map. Both the ranges and particulars of objects unseen (but shown on the map) should be stated if important, and the position and extent of dead ground should always be noted.

Ranges are shown from one point, that from which the sketch was made. If that point be the centre of a position 400 yards in extent, in 1000 yards the difference of the range to any point from the centre and from the flank of the position would never be greater than 50 yards, that is with a visual angle of 30°.

The names and ranges of the various objects may be printed horizontally, diagonally or vertically. If there are many objects to be named horizontal lettering may become confused—lettering in diagonal lines is perhaps the best.

Compass Bearings.—All panorama sketches should show at least

one compass bearing, or the direction of the centre of the picture may be stated. It is advisable to note the bearings of the objects on the extreme right and left of the drawing; with these the sector of ground sketched can be at once noted on the map and map and panorama be read together.

Position.—The position from which the sketch has been made must be definitely stated, or it may be shown on a small sketch map at the foot. The height (of the position) above sea-level must be noted, also the height of any building or tree from which the sketch was made.

Signature.—The name, rank and regiment of the sketcher, also the date, hour, and state of weather, is shown in the bottom right-hand corner.

References.—Any features which are referred to in an accompanying report must have some letter or number, preferably in red, and enclosed in a circle on both sketch and report.

3. THE PRISMATIC COMPASS.

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1. THE COMPASS AND PROTRACTOR.

The Magnetic Compass.

This is a sensitive little instrument, of great use to the soldier, and liable to develop inaccuracies if not carefully handled.

There are several types of magnetic compass. The Service Prismatic Compass consists of a metal box, in the centre of which is a pin on which the magnetic needle rests. Attached to the needle is the compass card or dial, which is divided to show every degree, and has two sets of figures, one for direct reading and the other, the outer, which is reversed, for use with the prism. The centre of the card is luminous. On one side of the box is a clamping screw which lifts the needle off the pin when not in use, so preventing unnecessary wear and loss in accuracy. A little check-spring acts as a break and helps to make the card settle more rapidly. A prism, which can be focused by raising or lowering the little brass knob, is attached, and through it one can read the "bearing" on the card whilst at the same time looking through the little slit above—which acts like a back-sight—and aligning the hair line—"fore-sight"—on the hinged cover on some distant object (Plate XXX.). The "fore-sight"—technically called the sighting vane—is a hair line scratched on the glass window of the cover. Immediately above and below it are two small holes. Should the glass be smashed, wire or cotton can be threaded through them to form a new sighting vane.

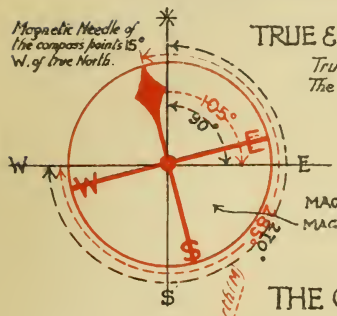
For night work the compass before use must be exposed to a bright light. To set it, the brass ring round the box, graduated to show every 5°, is used. The revolving glass cover of the box has a black directing mark painted on it, and corresponding with this a little brass nick on the rim. The cover is moved round until the brass nick, called the setting vane, is aligned with the required bearing as

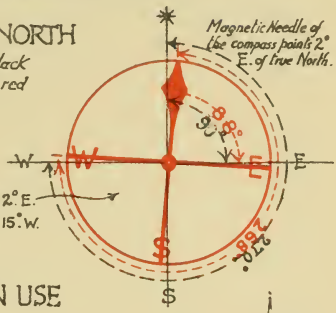
COMPASS BEARINGS

PLATE XXX.

TRUE & MAGNETIC NORTH

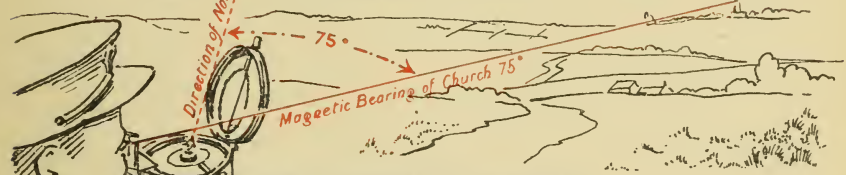
True bearings in black
The compass shown in red



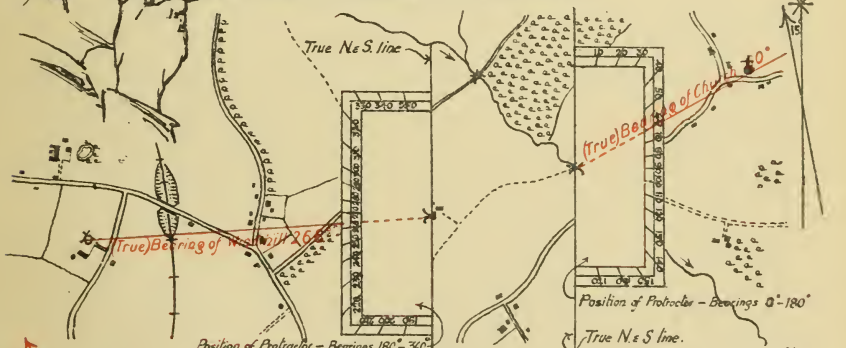


MAGNETIC VARIATION 2° E.
MAGNETIC VARIATION 15° W.

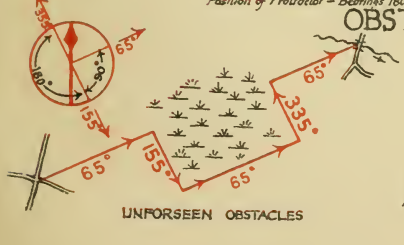
THE COMPASS IN USE



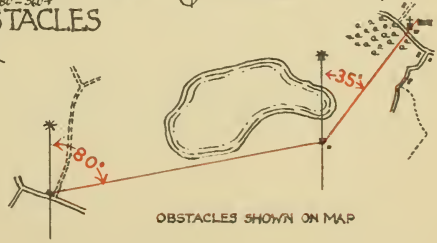
TAKING BEARINGS FROM MAPS


True N.& S. line
(True) Bearing of Church 60°
(True) Bearing of Windmill 265°
Position of Protractor – Bearings 0°-180°
Position of Protractor – Bearings 180°-360°
True N.& S. line.

OBSTACLES



UNFORSEEN OBSTACLES



OBSTACLES SHOWN ON MAP

shown on the brass ring, and is then fixed in position by the clamping screw with the milled head. When the compass is so held that the N. point is directly underneath the black directing mark, the two patches of luminous paint inside the hinged cover indicate the direction in which to march.

The compass just described is known as the "Mark VI" Service Prismatic Compass. The "Mark VII" is similar, with the exception of the luminous paint, which in the "Mark VII" is of radium compound, and need not be "charged" before using. Both the "Mark VI" and the "Mark VII" compass have dry cards, i.e. the card is balanced on a pivot, which takes all the weight, and owing to the tremors of the hand and the difficulty of holding the compass steadily in windy weather, the card is very "lively" and does not readily come to rest.

Essential qualities in a compass are sensitiveness and steadiness. Liquid compasses of various patterns are made in which the card, immersed in spirit, is steadier, and normally will come to rest in one-sixth the time a dry card takes.

A compass of the "Mark VII" type can be obtained in which the card is immersed in spirit and also has a transparent celluloid edge. Directly underneath the prism a spot of radium paint is fixed, and bearings can therefore be read at night. There are other types of liquid compass which owing to their special construction, such as the combination of float and card, and the use of an inverted pivot—reducing the weight of the card and giving greater buoyancy—are extremely sensitive and steady, and in which the reading of the card is not only magnified, but also shown in radium compound, making them particularly suitable for night work.

A magnapole is a compass which is used primarily for night marching, and works on the principle designed for night work with the service prismatic compass.

A compass which is likely to be used in another part of the globe should, if it has a large card, be taken to the makers, who will make any adjustment that may be necessary to allow for the compass "Dip."

True North and Magnetic North.

The magnetic needle of the compass always points to the Magnetic North, and not the True North or North Pole. The N. Magnetic Pole is situated at one of the Northern Islands of Canada, and if it were possible to march from the Magnetic Pole to the True North Pole as the needle is attracted by the Magnetic Pole according to the compass one would be marching due S., though in reality going due N.

In such a case the difference between True North and Magnetic North, known as the Magnetic Variation, would be 180°, or half the circumference of the compass card. The magnetic variation is not always 180°, but varies in different parts of the world, sometimes the needle points to the E., sometimes to the W. of true N. In London the magnetic variation is 15° W., Arras 14° W., whilst in Petrograd it is 2° E. It will be thus seen, and must always be remembered, that True North and Magnetic North, with few exceptions, do not coincide.

Maps are drawn with the top towards the true N. In the right-hand margin of a map there usually will be found a little diagram (Plate XXX.) which shows the lines of both true and magnetic N. The former is shown with a star, and the latter with an arrow-head, and a figure states the amount of the variation. There may be an annual increase or decrease, and knowing the date of the map allowance must be accordingly made if the map is an old one.

If there is no indication on the map of the amount of the magnetic variation, it can be found as follows :—Choose two objects on the ground—objects that can be identified on the map, and preferably at least a mile apart. From one point take a "bearing" with the compass on to the other, and note the reading. Join the two points on the map. Through the representation of the object from which the compass reading was taken, draw a true N. and S. line. The difference between the angle made by this line and the line joining the two points and the reading given by the compass will be the amount of the magnetic variation. If without a map, a true N. and S. line must first be ascertained from the sun's shadow or a known star—e.g. the pole star. This line is indicated on the ground,

and compared with the direction of the North as shown by the magnetic compass.

True North is always referred to in operation and other orders. Since the magnetic needle of the compass points to the magnetic N., and the "bearing" of a position is given in relation to true N., it will be seen that some adjustment must be made before using the compass to march by (Plate XXX.).

If in London (Mag. Variation 15° W.) and told to march due E.—90° true—15° must be added, and the compass bearing will be 105°. If the magnetic variation is 15° W. when the compass card is at rest and the needle pointing to magnetic N., the position of true N. is indicated by the reading of 15°. True E., 90° to the right of the N., must be 105° as shown on the compass card. Plate XXX. will explain this. Similarly, if told to march due West—270° true—the magnetic bearing would be 285°. If at Petrograd (Mag. Variation 2° E.) and told to march due W.—270° true—2° must be deducted, and the compass bearing will be 268°. In this case when the magnetic needle is pointing to the magnetic N., true N. will be 358°, or 2° to the left of magnetic N., 270° the true bearing on which it is desired to march added to 358° = 268° (Plate XXX.). 90° true would be 88° magnetic.

If a true bearing is taken from a map and it is desired to march by compass on that bearing, or, with the compass identify in the distance the spot of which the bearing is given, it will be seen that it is necessary to add or deduct the amount of the magnetic variation for the locality according to whether the variation is to the W. or the E. of true N. Conversely, it must be obvious that if a bearing has been taken with a compass on to a distant object, and it is required to draw this bearing on the map in order to identify the object, the amount of the magnetic variation must be deducted if the Mag. Variation is W., and added if E.

Bearings.

The points and degrees of the compass are used to express the direction of one object from another. A bearing is the angle a line makes with the N. line, and is expressed in degrees. It may be

true or magnetic according to whether it expresses the angle made with the true or magnetic N. line. If standing on a road which runs true N. and S. with a church some distance away to one side, and the angle between the road and a line joining one's position with the church is 48°, that would be the true bearing of the church. In effect, a bearing is the line of direction.

On maps the bearing, or direction of one object from another, is found by using a protractor. The degrees of the compass are always measured clockwise from the N., and protractors are graduated accordingly. The service protractor, an extremely useful article, is rectangular, and measures 6 in. by 2 in. The long side with the little arrow head should be considered as a true N. and S. line. On the bevelled edge the degrees are marked ; the outer row of figures gives the readings 0 to 180, and by turning the protractor round readings from 180 to 360 can be taken from the inner row.

To take a bearing from a map it is necessary to draw first a true N. and S. line through the representation on the map of the place at which one is stationed. A line parallel to the right or left sides of the map if it is drawn with the top facing the N. will give the line approximately, but it should be noticed that the line of true N. as shown in the margin is frequently not absolutely parallel to the side, and in such cases the line must be drawn parallel to the true N. line, or a meridian, if shown.

A meridian of longitude is a true N. and S. line. There is a ruling meridian for each country, and maps of the area through which the meridian passes have sides which are true N. and S. lines.

All the sheet maps of a country have their sides square to one another in order that the sheets may be correctly pieced together. Meridians of longitude converge to the N. pole ; as there is one ruling meridian for the country mapped, and all the maps have sides which are parallel to one another, the further the area shown on map is from the ruling meridian the greater will be the difference between the sides of the map and the line of true North.

Whenever possible a meridian should be drawn—in ink—across the centre of the map, and N. and S. lines can be readily indicated parallel to this whenever required.

Having ascertained the true N. and S. line, next draw a line from the point at which one is stationed to the point which it is desired to reach, and produce, if necessary, so that the line shall be about 4 in. long, and protrude beyond the protractor (Plate XXX.). To ensure accuracy a finely-pointed pencil only must be used. Place the protractor on the map so that the point of the arrow is exactly on the spot from which the bearing is being taken, and the edge of the protractor aligned with the N. and S. line. If the bearing to be taken is on the E. side of the line—0° to 180°—the protractor will be placed on the right side of the line; if to the W.—180° to 360°—it will be on the left. Note the reading on the edge of the protractor where the line joining the two points passes underneath. This gives the angle or bearing of the object. To obtain the magnetic bearing to enable one to march on the object by compass the amount of magnetic variation is added or deducted, according to whether the variation is to the West or the East.

When bearings are taken on to objects in the country, and it is desired to plot them on the map in order to identify them, a true N. and S. line is drawn through the representation of the spot from which the bearing has been taken, and the reading in degrees on the compass minus or plus the amount of the magnetic variation is marked off with the protractor. A line is drawn joining this mark with the spot from which the bearing was taken, and if necessary produced. It will be then seen through which feature the line drawn passes.

If plotting numerous bearings on a sketch map as it is being made, it will save time if a few lines showing the direction of magnetic N. be drawn across the paper (Plate XXXII.). The readings obtained with the compass can then be plotted directly from them without adding or deducting for the magnetic variation.

Correcting a Compass.

It has been shown how bearings are taken from a map in order to march directly to any given spot, and also what allowances it is necessary to make. Before using the compass, however, for any purpose, it is necessary to know if the instrument itself is accurate.

Errors may arise in the compass through wear, or they may be initial errors, such as want of parallelism between the axis of the magnetic needle and the N. and S. line of the card. Errors such as these will not render the compass useless, as the amount can be ascertained and allowance made. To do this a bearing is taken on a map from one well-defined object to another some miles away. The reading is then taken with the compass from one of these selected points to the other, and after allowing for the magnetic variation any difference between the bearing as given on the map and read by the compass will be the error, and must always be taken into account.

It is advisable to check the compass by several bearings taken in different directions.

All compasses should be checked from time to time.

2. MARCHING BY COMPASS.

Marching by Day.

In marching by the compass whether in the daytime or at night it is important to remember that the instrument must be held steadily and away from either metals or other compasses, both of which will affect it.

In windy weather the card of a dry compass is very "lively." It is advisable then to kneel when taking a bearing, and support the elbow on the knee. Additional steadiness is given if the compass is pressed closely to the face. Use the check-spring very gradually, and always hold the compass horizontally, or the card will catch either on the glass cover or the bottom of the box.

Do not use the compass in the presence of iron—iron-ore in some parts of the world renders the compass valueless. It is well to stand as far away as 50 yards from a body of troops with rifles and bayonets, and if with a small patrol, men carrying rifles should not be allowed to come near. Never stand on an iron bridge or close to railings or railway metals. A compass placed on a wooden gate may be affected by the hinges and fastenings, and even the wire of the service cap has been known to deflect slightly the magnetic needle.

To march on a given bearing hold the compass to the eye, and as soon as the card is steady move the box slowly round till the desired reading is seen through the prism. Cast the eye upwards and note what distant object is aligned with the slit in the prismatic attachment and the hair line on the glass hinged cover, which is turned up at right angles to the box. Proceed to the object chosen and continue as before, until the final objective is reached. For the intermediate objectives which indicate the correct line of direction or bearing always pick the most distant conspicuous features visible.

When there is much "dead ground" to be crossed time can be saved by sending a man ahead to some prominent position and signalling to him when he is on the correct line of direction.

In going through woods it is impossible to pick up objects any distance away, and trees, though apparently quite distinctive as seen through the slit over the prism, cannot be readily identified when the compass is moved from the eye. A man should be sent ahead showing a piece of white paper, and before he is lost to sight he is halted and directed to move to the right or left until on the right line of advance.

Marching by Night.

It should be remembered that a compass painted with ordinary luminous paint must be "charged" before using. This can be done either by exposing it to the daylight or any bright artificial light—an electric torch will do—or burning magnesium wire. It should be charged sufficiently to last for the whole night.

If using the Service prismatic compass the glass cover with the black directing mark is moved round until the setting vane is aligned with the bearing on which it is desired to march, as shown on the brass ring round the box. The cover is then clamped. When the magnetic N. point, which is made visible by the luminous paint, is directly under the black directing mark the two patches of luminous paint on the hinged cover indicate the direction in which to march. The compass must be so held that the user is standing squarely to the line of direction.

If not a dark night, the lid of the compass must be tilted upwards and some object on the skyline noted which is in alignment with the luminous patches. If a starlight night, a star should be observed which is on the correct alignment. To do this a pencil or stick may be held in prolongation of the luminous line. It is possible to march on one star for a short time—5 or 10 minutes—and then another should be chosen.

On very dark nights with no stars visible a guide having a piece of paper painted with luminous paint on his back may be sent

ahead in the right direction and told to halt as soon as he is likely to disappear from view. The man using the compass notes the position of the guide in relation to the correct line as indicated by the luminous patches, and marches himself to what he believes to be the right spot.

If marching by night with troops it is unwise to continually halt them whilst examining the compass. To avoid this a file of men should walk between the man with the compass and the company or platoon. The compass is examined, and, having ascertained the direction, the guide sets off briskly for a hundred yards or so and the file opens out. When a halt is made to examine the bearing again the file closes up, but before the company need halt the man with the compass moves off again, the file opens out, and so on continuously.

A file of men between the guide and troops is always an advantage as delays are thereby avoided in getting through hedges or round ponds and other minor obstacles. To count the paces one man should be specially detailed.

Night marching is simplified by using a liquid compass; and preferably one with the degrees shown in radium paint.

Obstacles.

When a bearing is taken from the map with the intention of marching to a given spot it is necessary to look for possible obstacles (Plate XXX.). If a lake or marsh should cross the line of direction two bearings are required. The first is taken to any point such as a building, bend in a road or corner of a wood on one side of the obstacle. Through this point a N. and S. line is drawn and a second bearing taken to the final objective. If there is no feature shown on the side of the obstacle which could be identified on the ground, any two bearings must be drawn such as will clear the obstacle, and the length in yards of the first bearing must be scaled so that it shall be known when marching at what point to change to the second bearing.

In the case of unforeseen obstacles it is necessary to adjust the bearings whilst on the march (Plate XXX.). When the obstacle is

encountered, set off at right angles to the original bearing, at the same time counting the paces. When the obstruction is passed laterally, proceed on the proper bearing and take up the original pacing if marching for a stated distance. When beyond the obstacle, march again at right angles, in this case in the diametrically opposite direction to the one taken when the obstacle was first met with, and after having marched for the number of paces taken when first turning off at right angles, one will be back on the original line of direction and can proceed without further difficulty. If the obstacle is a small one there is no need to set off at right angles by the compass; for a short distance the necessary direction can be judged.

The method just described applies especially to night work. In the daytime a point can usually be picked up beyond the obstacle to which one can go without taking any further bearings. It may also be possible to pick up the line of direction from the far side of the obstacle by taking a "back bearing" on to a point left when the obstacle was first encountered. A back bearing is the reverse of the forward bearing. Thus, if the forward bearing is between 0° and 180°, 180° will be added; if between 180° and 360°, 180° will be deducted, and the necessary bearing is obtained.

3. THE COMPASS IN MAP MAKING.

Triangulation.

It has been pointed out that in map sketching the chief object is to obtain a framework of fixed points—generally the most prominent objects—about which the details can be filled in by eye. This framework—in fact more than a framework—is usually obtained by enlarging from a small scale map, or it can be obtained by drawing rays, as for a range card, in the way already explained. In unmapped country, or when it is necessary to supplement the information shown by existing surveys, with the prismatic compass it is possible to fix more or less accurately the position of any number of features. The method adopted is called Triangulation, and is that which is used in making Ordnance and other maps with an instrument measuring angles to one second, and known as the theodolite.

The principle of triangulation is simple. If the length of one side of a triangle (which may be called the base) and also the two angles at the base are known then the length of the two remaining sides and position of the apex can be fixed.

In map sketching by triangulation it is necessary to first choose, in a position which is central as regards the area to be mapped, the "base line." This is an imaginary line joining two prominent objects, and should be over fairly level ground, free from obstructions, so that it can be easily paced and as long as it can be conveniently made. The ends of the base line must not only be well marked—artificially if necessary—and easily seen, but in positions from which good views of the surrounding country can be obtained. The bearing and length of the base line is noted, and it is drawn to scale and in the proper direction on the paper.

Suitable objects to form points in the framework of the sketch

are chosen from one end of the base line. If these points are visible from the other end, compass bearings are taken on to them and plotted on the paper. The map-maker then returns to the other end of the base line and takes bearings on to the same objects. The intersection of these bearings with the first bearings taken will give the position of the objects, since each forms the apex of a triangle, and so the framework is constructed.

If the area to be mapped is extensive subsidiary base lines may be formed. For these lines joining any two features the positions of which have already been ascertained can be used, providing they conform to the conditions laid down for the selection of a base. By triangulation from the new base line points further afield can be obtained.

In order to obtain accurate results it is necessary that the angles formed by the bearings be neither distinctly obtuse nor acute.

Map making by triangulation can be carried out without a prismatic compass if a "plane table" be used. A plane table consists of a tripod to which is attached a board or table top. This is free to revolve horizontally, thus enabling the sketch to be rapidly set when moved to any position. A straight edge or "sighting vane ruler" is pivoted in turn on to the points marking the ends of the base line and aligned on to the various objects. Rays are drawn on the paper and these take the place of compass bearings.

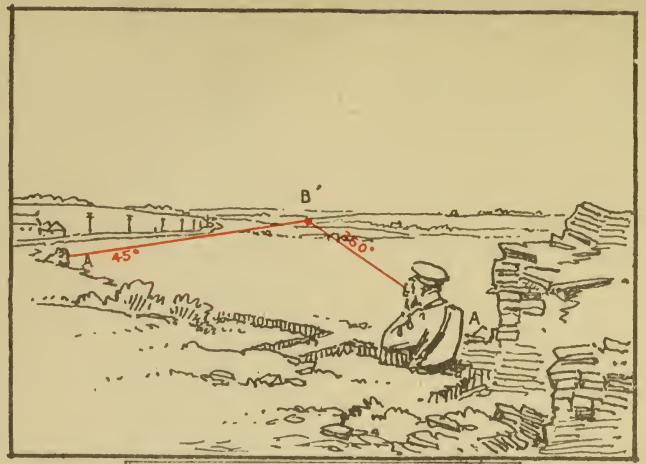
Adding Information to Maps.

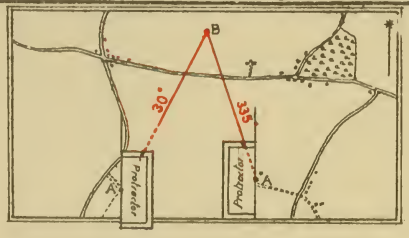
Whilst the making of maps, especially of large areas, by the method of triangulation may be the work of specialists only, the principles involved will be found useful by anyone to ascertain ranges and the position of distant landmarks, or hostile guns, machine-gun emplacements, points in the enemy's trenches, redoubts, etc. Examples are given on Plates XXXI. and XXXII.

On Plate XXXII. A. B. represents a trench. The points C. D. are definitely fixed on the map, C. being at the junction of a road, and D. at the corner of a demolished farm. C. D. therefore can be used as a base line. Somewhere to the front an enemy machine-gun is

TRIANGULATION

Position of an object found by the intersection of bearings taken from two Known points.



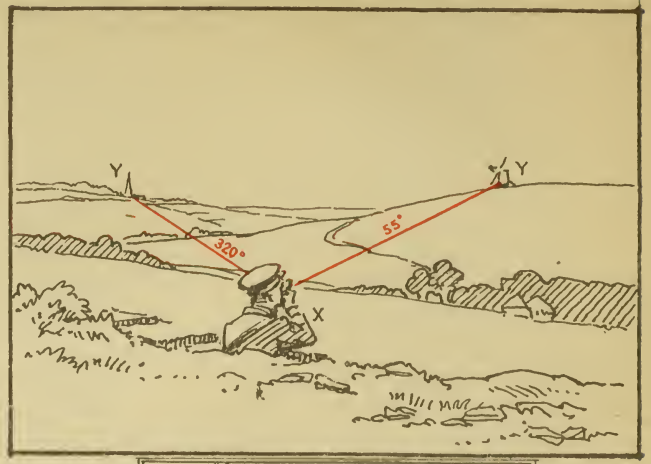


MAP SHOWING BEARINGS PLOTTED

RESECTION

PLATE XXXI.

Own position found by the intersection of bearings taken on to two Known points and produced backwards.



MAP SHOWING BEARINGS PLOTTED

noted and observed to be in some bushes. There is nothing however to show the position on the map. Bearings on to the gun are taken from C. and D., and, after deducting the magnetic variation, are plotted. The intersection shows the position on the map, which can now be communicated to a Battery Commander. See also Plate XXXI.

It is not always necessary that one man should take both bearings. Given an extended line of entrenchments accurately shown on the map, one man could take a bearing, say of a gun flash, from his position, and a second man take the bearing of the same flash from another part of the line, perhaps a mile away from the first. If both bearings and the exact positions from which they were taken are known the position of the gun is found.

One's own entrenchments are not always shown on maps, or, if the general line is shown, it may not be absolutely correct for obvious reasons. Before taking any bearings, therefore, it is often necessary to fix accurately one or two positions in the line—preferably two—to form the "base line." These can be found by resection from any permanent features. It is wise to have several points thus fixed in any line of trenches.

The object of resection is to fix one's own position exactly from two known points. Resection without a compass has already been explained on page 64. To resect a position with a compass (Plate XXXI.) bearings are taken on to two well-defined objects in the country which can be identified on the map. Through the representation of the objects N. and S. lines are drawn, and, after allowing for the magnetic variation, the bearings are plotted and produced backwards. The intersection marks on the map the point at which one is standing. The angle made by the intersection should be neither obtuse nor acute; this should be borne in mind when selecting the two objects on which the bearings are to be taken, the difference in the two bearings never being less than 40° or more than 120°. If standing on a road one's position can be resected by taking a compass bearing on one object only.

Compass bearings can be taken through a periscope. To ensure accuracy it is necessary that the periscope be firmly secured in an

upright position and that the two mirrors should be in parallel planes. With collapsible periscopes unless care is taken the mirrors are often not quite parallel to one another.

When there is nothing to act as a base line for triangulation on the map, one can be made by choosing any two points, noting the bearing one from the other, and pacing the distance. This line can then be drawn to scale and in the proper direction on the paper.

Various uses to which the method of triangulation can be put (such as ascertaining the width of a river) will suggest themselves.

Positions of objects can be found by taking one bearing only if the distance can be ascertained by range-finder or accurate estimate.

Traversing.

The method of traversing has already been referred to in Map Sketching, when it was shown that if an enlargement could not be made of a route the sketch could be drawn by taking "rays" with a straight edge. Traversing with the compass is more accurate (Plate XXXII.).

As much of the country as possible must be shown on each side of the route. The starting point will be at the foot of the sheet, and it is necessary that the sketch be so placed that the general direction of the road or river will run up the centre of the paper.

To place a traverse correctly on the sheet the direction of the N. point must be obtained as follows:—The true bearing of the general direction of the route is noted and will be represented by a line drawn up the centre of the paper. On this line mark any point. Above it place the protractor, and, keeping the arrow head on the point, move the protractor round until the degree for the general direction of the route is directly over the centre line. The edge on which the arrow head is marked will then represent the N. and S. line, and a line is drawn accordingly. If the bearing is from 0° to 180° the direction of N. will be the left of the line, from 180° to 360° it will be to the right.

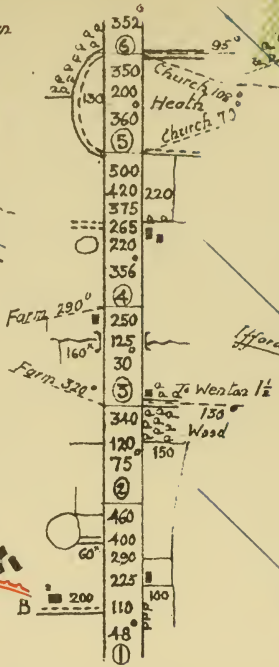
When the position of the true N. and S. line has been thus found the magnetic variation should be shown and a series of magnetic

THE COMPASS IN MAP MAKING.

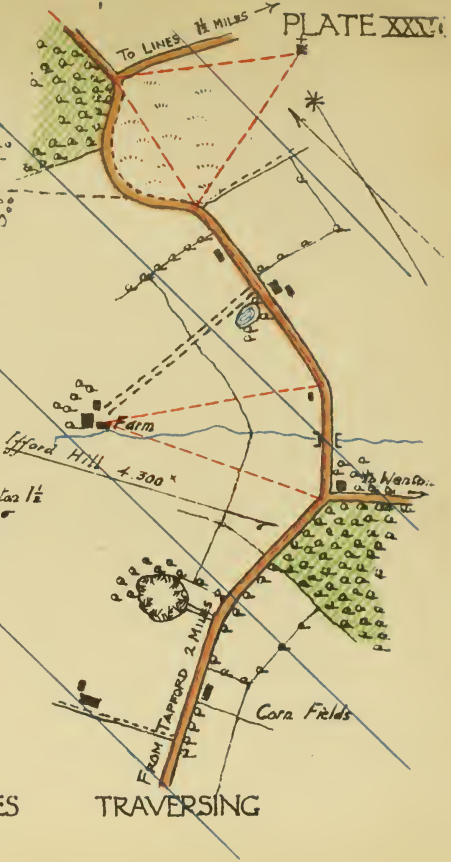
& IN ASCERTAINING POSITIONS OF DISTANT OBJECTS.

PLATE XXV.

TRIANGULATION



FIELD BOOK NOTES



TRAVERSING

meridians drawn lightly across the paper. From the meridians all the bearings taken in making the traverse can be plotted directly without conversion to true bearings.

The actual direction of each straight length of the route is obtained by taking a compass bearing on to some object at the first bend. The first bearing is plotted and the distance to the object paced and drawn to scale. From the bend, the position of which is now fixed, a second bearing is taken on to another object at the next change of direction, the distance is paced, and so on until the traverse is complete. For both sharp bends and slight deviations the bearings may be taken across country to distant points on the road or river, and the windings be put in on either side by eye.

Houses, fences, woods, bridges and other details near to the traverse line are put in as the distances are paced. Bearings are taken to show the direction of streams or railways crossing the road traversed or other roads running into it, and the positions of objects some way from the road may have to be ascertained by triangulation—using a length of the traverse as a base—or offsets. An offset is a line set off at right angles (usually by eye) to a traverse line. Along it is paced, or estimated, the distance to the object required.

Contour lines may have to be shown, and also indications of important positions commanding the route. It may also be advisable to mark the gradients of the road. Bearing in mind the object for which the sketch is being made, information is shown accordingly either on the face of the drawing or by tabulated footnotes.

On a road traverse each mile should be marked by drawing horizontal lines across the paper, numbering them from the starting point.

As with all military sketches, a traverse is completed by the addition of a suitable heading, signature with date, and scale.

Traversing may take the place of triangulation for map-making when the view is limited, such as in wooded country, and points for a framework cannot be fixed. Details of maps may also be filled in by this method.

Traversing is the method adopted in making trench plans.

Field-Book Notes.

In the reconnaissance of roads and rivers it is not necessary that the traverse should be drawn on the spot; entries may be made in a note-book and the traverse plotted afterwards (Plate XXXII.).

A "chain column"—two parallel lines $\frac{1}{2}$ inch apart, representing the single line of the traverse—is drawn in the centre of the book. The number of the traverse station (the point from which a new bearing is taken), the forward bearing and the distance paced are noted in this column, and also the distances—which must be inclusive for each length of the traverse—to objects close to the road or river side, always working upwards from the bottom of the paper. On either side of the chain column are shown the features passed, with notes as to their positions, etc., and the bearings taken from various traverse stations to distant objects. Here also is noted the width of the road.

The notes must be systematic, clear and legible.

This method is to be preferred to making the sketch as the ground is covered in bad weather and when there is only a limited time in which to go over the route.

4. TRENCH PLANS.

Trench Sketching.

The conditions for the making of sketches in trench warfare differ from those which obtain in open fighting.

The general indication of the position of one's own and hostile trenches and trench elements may be obtained by aerial photography, but there is much valuable information which can only be shown adequately by a survey made within and under the cover of the trenches themselves. Traversing, therefore, as described for the making of route sketches, is the most satisfactory way of making trench plans.

Trench plans must show small details, and are made to larger scales than those used in field sketching. The positions of natural features of the ground and representation of the relative levels will not be required, since they are already shown by the general maps of the area, but the trenches themselves, with large scale sections and notes of the various features and the system of construction and state of repair, are essential.

Owing to the presence of rifles, machine guns, steel plates and steel revetting materials, special care must be taken in the use of the compass, and the accuracy of the work should be tested wherever possible. In the case of trenches wholly revetted with metal it is advisable to make the traverse by taking rays with the straight-edge (Road Sketches, p. 54), but normally the compass traverse is quicker and better.

The finished sketch is not made on the spot (unless the traverse is made with the straight-edge, in which case the lines of the trenches

themselves must be completed as the work proceeds). A preliminary rough sketch is made, showing all necessary bearings, dimensions and notes, and the whole is drawn out carefully on the completion of the survey.

The importance of making the preliminary sketches and notes systematically is obvious.

The Compass Traverse.

What is meant by a compass traverse has already been explained elsewhere.

The starting point will depend upon how much of the trench system is to be shown, whether the front line of trenches only is required or the support and reserve trenches in addition. In the former case a start should be made from one end of the supervision trench, and in the latter case it is advisable to start at the rear of the system, and preferably from a point which can be identified on the available maps of the area.

A sketch is made in single line of the whole system, which, though it will not be to scale, should be approximately correct in its proportions. All trenches should be shown, and dug-outs, latrines, sniping and bombing posts, emplacements, stores, etc. Compass bearings of each straight length of trench are then taken, always keeping the line of sight in the centre, and the distances are paced in yards or taken with a measure, if procurable. The bearings (magnetic) and distances are shown on the rough sketch, as indicated by the red lines and figures in Plate XXXIII. The positions of all features passed are carefully noted in the right place, and the dimensions are added.

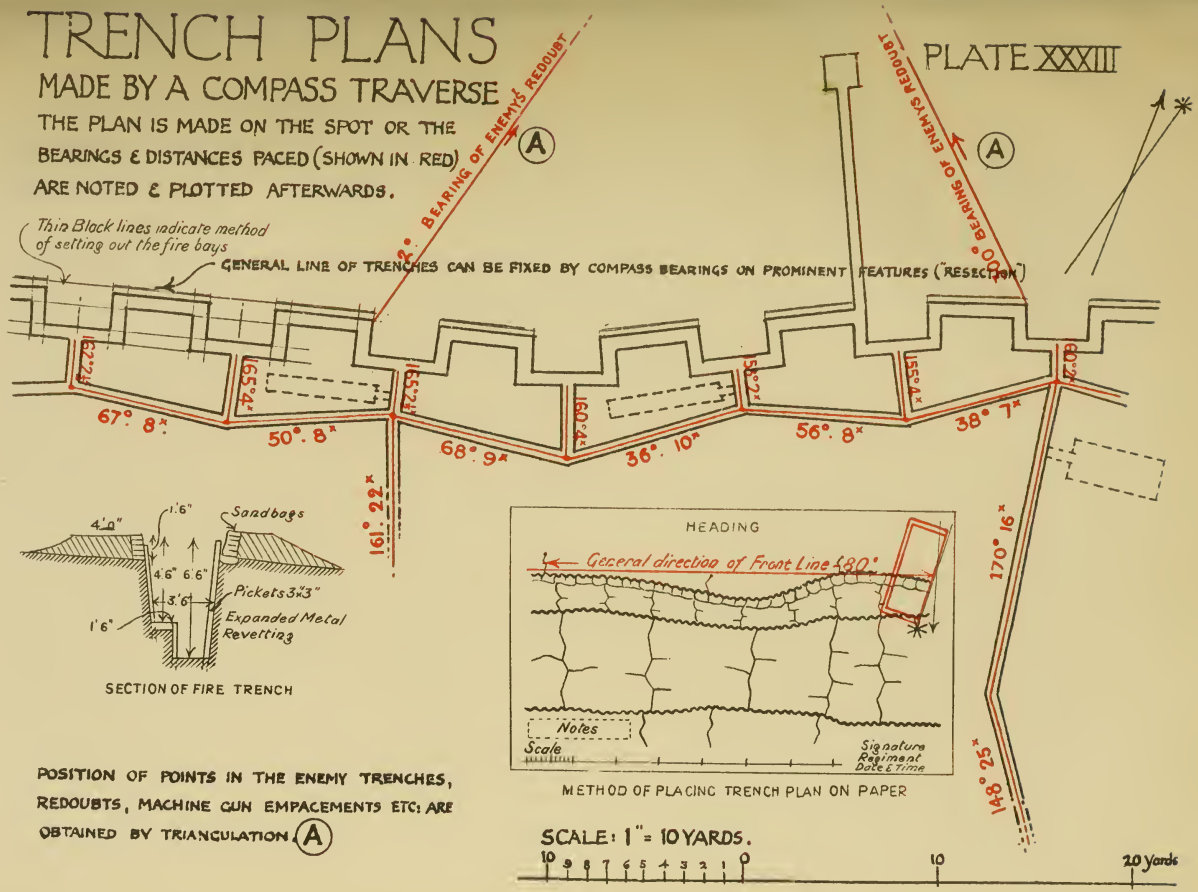
A section is drawn of the trench, or several sections if the sizes and construction vary in different parts. On the sections are figured the depth, width at bottom and top, height of fire step, and particulars of the parapet and parados and methods of construction are noted. If required, sections may similarly be made of dug-outs and emplacements.

TRENCH PLANS

MADE BY A COMPASS TRAVERSE

THE PLAN IS MADE ON THE SPOT OR THE BEARINGS & DISTANCES PACED (SHOWN IN RED) ARE NOTED & PLOTTED AFTERWARDS.

PLATE XXXIII



The actual fire bays are not traversed with the compass. As the positions of all communicating trenches leading up to the firing line are fixed by the traverse it is only necessary to count the number of fire bays between them, and to note the width and depth of the earth traverse between each fire bay, and they can be fitted in without further measurement on the finished plan (Plate XXXIII.).

Points in the enemy's trenches can be fixed by triangulation, and this must be done with the compass and periscope.

Errors will creep in when traversing lines composed of but short straight lengths with many changes in direction, and when the compass needle may be affected by metals or the pacing is not dependable. In order to obtain accuracy in the whole drawing, and the proper relation of part to part, the sketch should be checked by one or more of the following methods :—

(1) Comparison with an aeroplane photograph, which will give the general proportions correctly.

(2) Points on the ground. Such natural features as are shown on the general map of the area should be noted in their correct relation to the trenches. They will accordingly definitely fix the position of a certain number of points.

(3) Cross bearings. A few cross bearings taken from points free from enemy observation will, given one or two satisfactory base lines, fix several points accurately, and so form a triangulated framework of the whole.

The exact position of any point in the trenches can be fixed on the general map by resection from prominent objects.

Plotting the Traverse.

The scale and method of placing the drawing on the paper are the first points to be considered.

The scale, which will be one of yards to the inch, will of course be governed by the size of the paper and the area of the trench measured. Allowing for the necessary margin, if the greater width of the paper be divided into the greater dimension of the area of

trench—frontage or depth—the result, taking the nearest round number, will give the desired scale, thus :—

Area of trench : 520× by 310×.
Size of paper (less margin) : 10 in. by 7 in.
520 ÷ 10 = 53.
Scale : 50 yards to 1 inch.

The necessary scales can be drawn from the scale of inches and tenths on the service protractor.

The sketch must be placed on the paper, the top edge of which will represent the direction of the enemy, to show conveniently not only the whole area, but in some cases points in the enemy's front line. The general direction of the firing line will be represented by a line parallel to the top edge, and the direction of the N. point is found as described in the making of a road traverse (page 102).

Magnetic meridians are drawn lightly across the paper, and, marking the starting point of the traverse in the proper position, all the bearings are directly plotted and the several lengths of the trenches and positions and dimensions of all features drawn to scale. The trenches are shown by two firm pencil lines, indicating to scale their width. Those which are in a bad state of repair should be shown by colour, and dug-outs and other features under the ground are drawn with dotted lines.

When all the trenches which have been traversed with the compass are plotted, the fire bays are drawn as follows (Plate XXXIII.) : From the centre point of contact of each communicating trench with that forming the firing line draw short perpendiculars. These will represent the centres of the earth or sand-bag traverses. Divide the space between these lines according to the number of traverses and fire bays, and on each of the dividing lines mark off the width and depth of the earth traverse. All that now remains to be done is to indicate the width of trench running round the traverse, and the fire bays, showing the fire steps, are drawn in, linking up the whole line.

Wire obstacles should be shown by their proper conventional sign.

Completing the Plan.

Lettering.—To the plan must be added all necessary lettering and notes of the following features :—

1. Dug-outs.
2. Headquarters.
3. Stores.
4. Latrines.
5. Emplacements.
6. Bombing Posts.
7. Sniping Posts.
8. Listening Posts.
9. Obstacles.
10. Drainage.
11. Points of Tactical Importance.

If the notes are numerous and the scale of the map small, to avoid covering the face of the drawing with lettering reference numbers may be used and the information shown at the foot of the sketch, or on another sheet, when it may partake of the nature of a report.

Sections.—Sections must be shown of the trenches, but to a larger scale than that used for the plan, to enable the method of construction to be clearly shown Plate (XXXIII.).

Heading.—The heading should state the name of the regiment holding the trenches, and their exact position by map reference.

Signature.—As on all other military sketches, the signature, with rank, regiment and date will be shown in the bottom right-hand corner, but as heavy shelling might occur between the time of making the sketch and the time of plotting it, effacing trenches marked as being in good repair, both the time of making the sketch and plotting the finished drawing should be shown.

North Point.—This is shown in the top right-hand corner when the sketch is first plotted. The magnetic variation must be shown.

Scale.—This is drawn and properly figured, at the foot of the paper.

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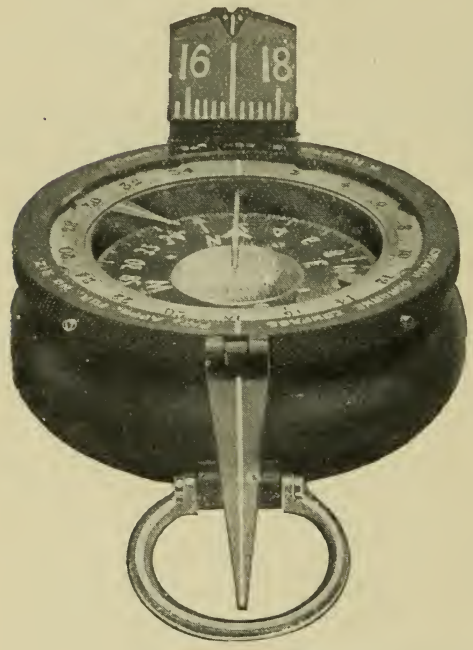

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